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DIFFERENT APPROACHES TO BIODIVERSITY CONSERVATION

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There are two approaches in biodiversity conservation: In-situ Conservation and Ex-situ Conservation.

In-Situ Conservation

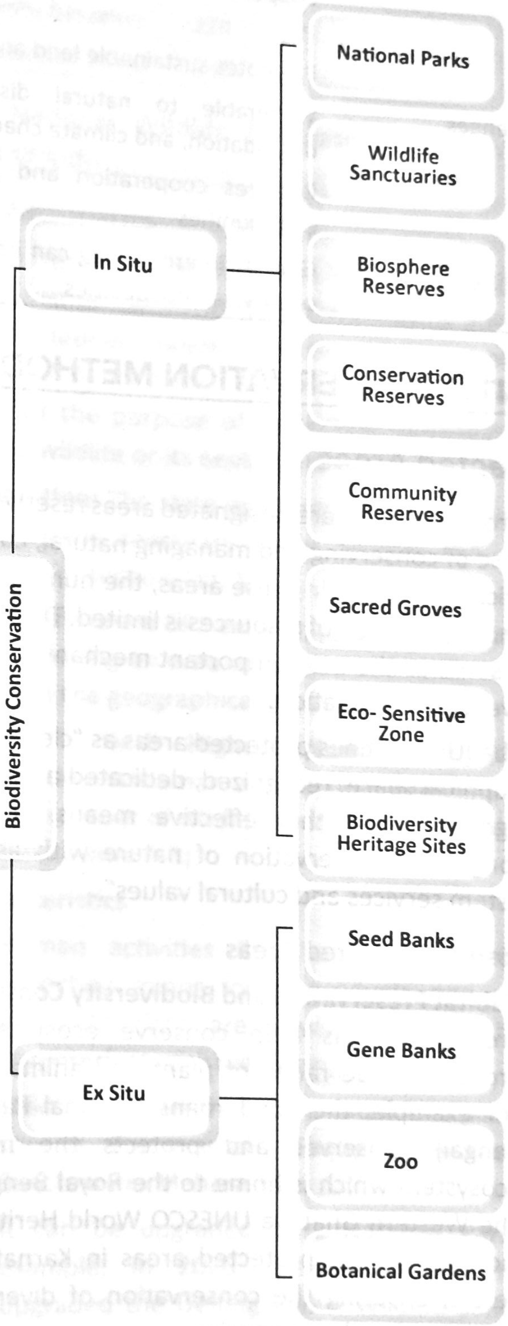
It refers to the protection and management of species and ecosystems within their natural habitats. It involves various techniques such as:

- Designation of Protected Areas such as national parks, wildlife sanctuaries, and biosphere reserves.
- Efforts for Restoration of habitats such as reforestation, wetland restoration etc.
- Conservation initiatives for species like establishment of tiger and elephant reserves.

Ex-Situ Conservation

It is the conservation of biodiversity outside its natural habitat. This method is used when in-situ conservation is not feasible or requires additional support. It involves various techniques such as:

- Seed Banks for collection and storage of seeds
- Gene Banks for preservation of genetic material of plants, animals, and microorganisms.
- Captive Breeding Programs
- Botanical Gardens and Arboreta for cultivating and display diverse plant species
- Zoos and Aquariums for housing and caring for various animal species



Approaches to Biodiversity Conservation

Comparative Analysis of In-Situ and Ex-Situ Conservation Methods

Basis	In-situ Conservation	Ex-situ Conservation
Focus	Protection and management of species within their natural habitats	Conservation of Species outside their natural habitats
Primary Techniques	Protected areas, habitat restoration, species recovery programs	Seed banks, botanical gardens, zoos, aquariums, gene banks, captive breeding programs
Conservation Scope	Entire ecosystems and their biodiversity	Targeted species or genetic material
Advantages	Preserves ecological processes and interactions	Acts as a safety net for species at risk of extinction
	Supports natural adaptation and evolution	Allows for controlled breeding and genetic management
	Promotes sustainable land and resource use	Facilitates research, education, and public awareness
Challenges	Vulnerable to natural disasters, habitat loss, degradation, and climate change	May lack natural ecological interactions and behaviors
	Requires cooperation and participation of local communities	Captive-bred individuals may face challenges in wild survival
	Genetic interbreeding can impact genetic make-up or survival probabilities	Establishment and maintenance of facilities is expensive

IN-SITU CONSERVATION METHODS

Protected Areas

Protected areas are designated areas reserved for the purpose of conserving and managing natural, cultural, or historical resources. In these areas, the human activities and the exploitation of resources is limited. The protected areas serve as the most important mechanism of in-situ biodiversity conservation.

The IUCN defines protected areas as “clearly defined geographical space, recognized, dedicated and managed through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values”.

Purpose of Protected Areas

- **Habitat Preservation and Biodiversity Conservation**: Protected areas help conserve ecosystems and protect a wide range of plant and animal species. For example, the Sundarbans National Park (West Bengal) conserves and protects the mangrove ecosystem which is home to the Royal Bengal Tiger. The Western Ghats, a UNESCO World Heritage Site, includes several protected areas in Karnataka and Kerala, ensuring the conservation of diverse flora, fauna, and endemic species.
- **Protection of Endangered Species**: Protected areas are also established for conservation of several endangered species. For example, the Kaziranga National Park (Assam) is dedicated to protect the one-horned rhinoceros, the Vikramshila Dolphin Sanctuary (Bihar) is dedicated to protect dolphins.
- **Watershed Protection:** Several Protected areas often encompass watershed. The play a crucial role in safeguarding water resources. For example, the Periyar Tiger Reserve in Kerala protects the Periyar River catchment, ensuring the ecological integrity of the region and supporting the water needs of the local communities.
- **Scientific Research and Education**: Many protected areas serve as living laboratories and provide opportunities for scientific research and environmental education. For example, the Galápagos Islands in Ecuador have been designated as a protected area for scientific study and education.
- **Cultural and Historical Preservation**: Along with biodiversity conservation, protected areas also help in protecting several sites of historical, and cultural significance. For example, the Nanda Devi Biosphere Reserve in Uttarakhand protects the Nanda Devi peak and surrounding ecosystems of religious significance.
- **Recreation and Tourism**: Protected areas provide opportunities for individuals to engage in recreational activities such as hiking, wildlife safaris, camping, and nature tourism.

IUCN Classification of Protected Areas

The IUCN classifies protected areas into 6 categories

IUCN Classification of Protected Areas	
Category Ia – Strict nature reserve	Managed mainly for science
Category Ib – Wilderness area	Managed mainly for wilderness protection
Category II – National Park	Managed mainly for ecosystem protection and recreation
Category III – Natural monument or feature	Managed mainly for conservation for specific natural features
Category IV – Habitat or species management area	Managed mainly for conservation through management interventions
Category V – Protected landscape or seascape	Managed mainly for landscape/seascape conservation and recreation
Category VI – Protected area with sustainable use of natural resources	Managed mainly for sustainable use of natural ecosystems.

Protected Area Network in India

Protected Areas in India serve as a comprehensive framework for the sustainable conservation and management of biodiversity in national parks, sanctuaries, and conservation and community reserves across the varied biogeographic regions of the country. The **Marine Protected Areas** are also included under the broader term 'Protected Area'.

Legislations governing Protected Areas in India

There are several kinds of protected areas, which vary by level of protection depending on the laws of each country or the regulations of the international organizations involved. Protected Areas in India are constituted and governed under the provisions of **Wildlife (Protection) Act, 1972 and its amendments**. It is further complemented by several other Acts like-

- Indian Forest Act of 1927
- Forest (Protection) Act of 1980
- Environment (Protection) Act of 1986
- Biological Diversity Act, 2002
- Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights Act), 2006

Status of Protected Areas in India (as of Jan 2023)

India has a network of 998 Protected Areas (as per National Wildlife Database Centre, Wildlife Institute of India).

Category	No	Total Area (In sq. km)	Coverage % of Country
National Parks	106	44,402.95	1.35
Wildlife Sanctuaries	567	1,22,564.86	3.73
Conservation Reserves	105	5,206.55	0.16
Community Reserves	220	1,455.16	0.04
Total Protected Areas	998	1,73,629.52	5.28

Source: National Wildlife Database Centre, Wildlife Institute of India

Wildlife Sanctuaries

It is an area (other than area comprised with any reserve forest or the territorial waters) having adequate ecological, faunal, floral, natural, geomorphological or zoological significance. The wildlife sanctuaries are declared for the purpose of protecting, propagating or developing wildlife or its environment.

- **Declaration:** The **state government** declares an area as a wildlife sanctuary under Section 26A of the Wildlife Protection Act, 1972.
- **Status:** There are 567 existing wildlife sanctuaries in India covering an area of 122,564.86 km2, which is 3.73% of the geographical area of the country.
- **States/UTs with Highest Number of Wildlife Sanctuaries:** Andaman and Nicobar Islands has the highest number of wildlife sanctuaries (97) followed by Maharashtra (49).
- **Characteristics**
    - Human activities like harvesting of timber, collecting minor forest products and private ownership rights are allowed as long as they do not interfere with well-being of animals.
    - Wildlife Sanctuary can be created for a particular species. For example, Thane Creek Flamingo Sanctuary in Maharashtra
    - It can be upgraded to a National Park. For example, in 2020, the Assam government upgraded the Dehing Patkai Wildlife Sanctuary to a National Park.
    - During settlement of claims, before finally notifying the Sanctuary, the Collector can allow the continuation of any right of any person in or over any land within the limits of the Sanctuary.

National Parks

These are areas having adequate ecological, faunal, floral, geomorphological, natural or zoological significance. A national park is declared for the purpose of protecting, propagating or developing wildlife or its environment.

- **Declaration:** They are declared under Section 35 of the Wildlife Protection Act, 1972 and can be declared by both Central and State governments.
- **Status:** There are 106 existing national parks in India covering an area of 44,402.95 km2.
- **State with Highest Number of National Parks:** Madhya Pradesh has the highest number of national parks (11).
- **First National Park of India:** Jim Corbett National Park (previously known as Hailey National Park), established in 1936, is India's first national park.
- **Largest National Park:** Hemis National Park located in Ladakh is the largest National Park in terms of area (3350 km2).
- **Characteristics:**
    - National Parks have well-defined boundaries.
    - National Parks cannot be downgraded to the category of a sanctuary.
    - Within a national park, all human activities are prohibited except for those authorized by the Chief Wildlife Warden of the respective state
    - Any extraction or utilization of wildlife or forest resources necessitates the recommendation of the National Board for Wildlife

Community Reserves and Conservation Reserves

Conservation Reserves and Community Reserves were first introduced in the Wildlife (Protection) Amendment Act of 2002. These categories were added because of reduced protection in and around existing or proposed protected areas due to private ownership of land, and land use.

Conservation Reserves

The State Government can declare certain areas, especially those near national parks or sanctuaries, and those connecting protected areas, as conservation reserves under the Wildlife (Protection) Act, 1972 (Amendment 2002). This is done in consultation with local communities to safeguard landscapes, seascapes, plants, animals, and their habitats.

- **Status:** There are 105 existing Conservation Reserves in India covering an area of 5206.55 km2, which is 0.16% of the geographical area of the country.
- **State/UT having highest number of Conservation Reserves:** Jammu and Kashmir has highest number of Conservation Reserves (33) followed by Rajasthan (18).
- **First Conservation Reserve of India:** Tiruppadaimarathur conservation reserve near Thirunelveli District of Tamil Nadu, declared in 2005, is the first Conservation Reserve in India.
- **Characteristics**
    - Areas are designated as conservation reserves if they are uninhabited and completely owned by the Government of India and used for subsistence by communities.
    - Management of a Conservation Reserve is done as per provisions of the section 36B of the Wildlife (Protection) Act, 1972 (Amendment 2002).
    - The State Government shall constitute a conservation reserve management committee to advise the Chief Wildlife Warden to conserve, manage and maintain the conservation reserve.
- **Examples:** Ropar Wetland (Punjab), Anka Samudra Bird Sanctuary (Karnataka), Asan Wetland (Uttarakhand), Kanji (Ladakh), Saraswati Plantation (Haryana).

Community Reserves

These are privately owned protected areas that serve as buffer zones or connectors between existing national parks, wildlife sanctuaries, and reserved forests in India.

- **Status:** There are 220 community reserves in India covering an area of 1455.16 km2, which is 0.04% of the geographical area of the country.
- **States/UTs having Highest Number of Community Reserves-** Nagaland has the highest number of community reserves (114) followed by Meghalaya (74).
- **Management of Community Reserves**
    - The State Government establishes a Community Reserve Management Committee to oversee the conservation, maintenance, and management of the community reserve.
    - The committee will comprise five representatives nominated by the Village Panchayat and one representative from the State Forests or Wildlife Department under whose jurisdiction the community reserve is located.
- **Examples**: Gogabil Community Reserve (Bihar), Ethungya Tongti Project (Nagaland), Singchang Begun Village (Arunachal Pradesh).

Marine Protected Areas (MPAs)

A marine protected area is essentially a space in the ocean where human activities are more strictly regulated than the surrounding waters-similar to the parks on land. They are given special protections for natural or historic marine resources by local, state, territorial, native, regional or national authorities.

- It includes marine parks, nature reserves and locally managed marine areas that protect reefs, seagrass beds archaeological sites, mudflats, salt marshes, mangroves etc.
- In India, protected areas that fall-in whole or in part-within a swath of 500 m from the high tide line and to the marine environment are included in the Marine Protected Area Network.
- Goals of MPA's
    - To protect marine habitats and the variety of life they support like coral reefs, mudflats, salt marshes, mangroves etc.
    - To conserve historic sites
    - To ensure that the resources are sustainable-that they will not run out
- **Status:** There are a total of 128 Marine Protected Areas in India. There are four Marine National Parks in India. These include:
    - Gulf of Kutch Marine Sanctuary, Gujarat,
    - Mahatma Gandhi Marine National Park, Andaman & Nicobar Islands
    - Gulf of Kutch Marine National Park, Gujarat
    - Gulf of Mannar National Park, Tamil Nadu

Biosphere Reserves

Biosphere reserves are designated regions encompassing terrestrial and coastal/marine ecosystems, aimed at safeguarding both plant and animal wildlife while also fostering sustainable development. These sites are called **'learning places for sustainable development'.** The concept of Biosphere Reserves was put forward by United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1973-74 under its Man and Biosphere (MAB) Programme. The world's first biosphere reserve was established in 1979.

The MAB Programme: It is an international initiative launched by UNESCO in 1971 which aims to promote the **sustainable use and conservation of biodiversity** while considering the socio-economic well-being of local communities.

World Network of Biosphere Reserves: It is one of the key components of the MAB Programme which consists of internationally designated biosphere reserves, which demonstrate a balanced relationship between man and nature. These reserves serve as model regions for testing and implementing sustainable practices, integrating scientific research, education, and community involvement.

- A Biosphere Reserve is nominated by the national government as per the agreed criteria and must adhere to a minimum set of agreements.
- **Status:** There are 738 biosphere reserves in 134 countries, including 22 transboundary sites. These sites are distributed as follows:
    - 36 sites in 14 countries in the Arab States
    - 90 sites in 33 countries in Africa
    - 132 sites in 22 countries in Latin America and the Caribbean
    - 172 sites in 24 countries in Asia and the Pacific
    - 308 sites in 41 countries in Europe and North America

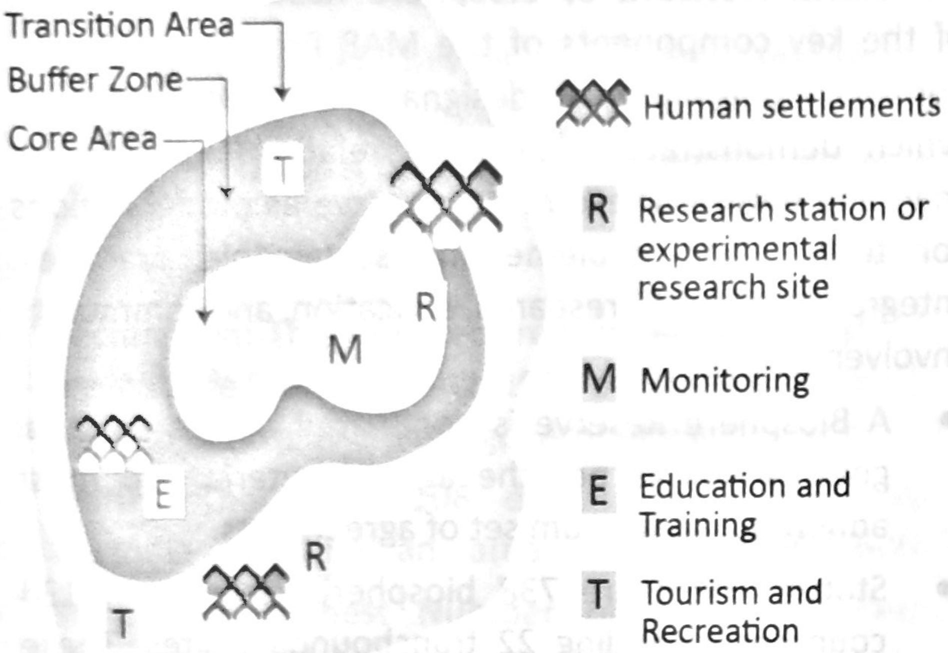
In 2021, UNESCO designated **Mura-Drava-Danube (MDD)** as the world's first 'five-country biosphere reserve. It covers 700 kilometers of the Mura, Drava and Danube rivers and stretches across Austria, Slovenia, Croatia, Hungary and Serbia. The region is popularly known as the "Amazon of Europe"

Functions of Biosphere Reserves: Biosphere Reserves actively engage local communities and various stakeholders in the planning and management processes. There are three main functions of Biosphere reserves:

- **Conservation Function:** It includes conservation of **biodiversity and cultural diversity.**
- **Development Function:** It includes promotion of socio-culturally and environmentally sustainable economic development.
- **Logistical Function:** It involves providing logistical support for development through research, monitoring, education, and training activities

Zones of a Biosphere Reserve: Biosphere Reserves are divided into three main zones-

- **Core Zone-** This zone provides strict protection to the wildlife. No human activity is allowed in this zone.
- **Buffer Zone-** This zone surrounds the core zone. Only limited human activity (Tourism, environmental education and research) is allowed in this zone.



Biosphere Reserve Zonation

- **Transition Area:** It is the outermost zone. Cropping, forestry, fishery and other activities are allowed here.

Biosphere Reserves in India

Designation: The Indian National MAB Committee identifies and recommends potential sites for Biosphere Reserve designation, adhering to UNESCO's guidelines and criteria. The reserves that meet the criteria are then admitted into the international network by the International Coordinating Council (ICC) of the MAB Programme, upon the country's request.

National Biosphere Reserve Programme: It is being implemented by Government of India since 1986. The major objectives of the programme are as follows:

- To conserve the diversity and integrity of plants and animals within natural ecosystems;
- To safeguard genetic diversity of species on which their continuing evolution depends;
- To provide areas for multi-faceted research and monitoring;
- To provide facilities for education and training; and
- To ensure sustainable use of natural resources through most appropriate technology for improvement of economic well-being of the local people.

Biosphere Reserves in India

List of Biosphere Reserves in India

Biosphere Reserve	Location	Rivers that pass through	Climate	Vegetation	Fauna	Other Important Facts
Nilgiri Biosphere Reserve	Part of Wayanad, Nagarhole, Bandipur & Mudumalai, Nilambur, Silent Valley & Siruvani Hills. (Tamil Nadu, Kerala & Karnataka)	Moyar, Bhavani, and Kabini	Tropical and subtropical mountainous climate, with heavy rainfall (2,500mm to 6,000mm) and temperature range of 4°C to 28°C.	Tropical and subtropical moist deciduous forests, sholas, and grasslands	Nilgiri langur, Nilgiri tahr, lion-tailed macaque, Indian elephant	• It was the first Biosphere reserve of India. • It includes Silent Valley National Park (Kerala), Mukurthi National Park (Tamil Nadu), Bandipur Tiger Reserve (Karnataka), Nagarhole Tiger Reserve (Karnataka), Mudumalai Tiger Reserve (Tamil Nadu), Wayanad Wildlife Sanctuary (Kerala), Aralam Wildlife Sanctuary (Kerala), Sathyamangalam Tiger Reserve (Tamil Nadu), Karimpuzha Wildlife Sanctuary (Kerala). • The Nilgiri mountains are part of the Western Ghats which was declared a UNESCO world heritage site in 2012. It is part of MAB program of UNESCO
Gulf of Mannar Biosphere Reserve	The Indian part of the Gulf of Mannar between India and Sri Lanka (Tamil Nadu).	Tamiraparani, Vaipar, Thamirabarani, and Manimuthar	Tropical monsoon climate, with high humidity and heavy rainfall (700mm to 2,500mm) and temperature range of 25°C to 35°C.	Coral reefs, seagrass beds, and mangroves	Dugong, sea turtle, blacktip reef shark, humpback dolphin	• It is the group of 21 islets lying off the Tamil Nadu coast between Thoothukudi and Dhanushkodi. • It was declared as the Gulf of Mannar Marine National Park in 1986. • It is a part of MAB program of UNESCO
Sunderbans Biosphere Reserve	Part of the delta of the Ganges and Brahmaputra river system (West Bengal)	Ganges, Brahmaputra, and Meghna	Tropical monsoon climate, with high humidity and heavy rainfall (1,500mm to 3,000mm) and temperature range of 20°C to 42°C.	Mangroves and wetlands	Bengal tiger, saltwater crocodile, Irrawaddy dolphin, spotted deer	• It is national park, tiger reserve & elephant reserve as well • It was declared as UNESCO World Heritage Site and RAMSAR Site. • It is part of MAB program of UNESCO. • It drives its name from Sundari trees that are found here. • It is also home to largest mangrove forests in the world.
Nanda Devi Biosphere Reserve	Part of Chamoli, Pithoragarh, & Bageshwar districts (Uttarakhand)	Dhauli Ganga, Rishiganga, and Alaknanda	Subarctic climate, with heavy snowfall and temperature range of -10°C to 15°C. Annual rainfall ranges from 1,000mm to 3,000mm.	Alpine and sub-alpine forests, meadows, and glaciers	Himalayan black bear, snow leopard, musk deer, bharal	• The core area of this reserve is consists of Nanda Devi National Park and the Valley of the Flowers National Park. • Both of these parks are declared as world heritage sites by UNESCO. • It is part of MAB program of UNESCO • Nanda Devi is the 2nd highest peak in India and 23rd highest peak in the world.

Biosphere Reserve	Location	Rivers that pass through	Climate	Vegetation	Fauna	Other Important Facts
Nokrek Biosphere Reserve	Part of Garo Hills (Meghalaya)	Simsang, Nitai, and Someshwari	Humid subtropical climate, with heavy rainfall (2,000mm to 4,000mm) and temperature range of 5°C to 25°C.	Tropical and subtropical moist broadleaf forests, bamboo and cane brakes, and grasslands	Red panda, Asian elephant, clouded leopard, barking deer	• Nokrek is the highest peak in the Garo Hills. • It includes Nokrek National Park. • It is part of MAB program of UNESCO.
Pachmarhi Biosphere Reserve	Parts of Betul, Hoshangabad, and Chhindwara districts of Madhya Pradesh	Tawa, Denwa, and Sonbhadra	Subtropical climate, with moderate rainfall (1,400mm to 2,500mm) and temperature range of 4°C to 35°C.	Tropical moist deciduous forests and teak plantations	Indian bison, Indian leopard, Indian giant squirrel, wild boar	• The Satpura National Park forms the core area of the reserve. • Bori Sanctuary and Pachmarhi Sanctuary forms the buffer area. • It is part of MAB program of UNESCO
Simlipal Biosphere Reserve	Part of Mayurbhanj district (Orissa)	Budhabalanga and Palpala	Tropical monsoon climate, with heavy rainfall (1,200mm to 2,000mm) and temperature range of 10°C to 40°C.	Tropical semi-evergreen and moist deciduous forests and grasslands	Bengal tiger, Indian elephant, gaur, sambar deer	• It derives its name from 'Simul' (Silk Cotton) tree. • The Simlipal National Park forms the core of the reserve. • Whereas, Hadagarh Wildlife Sanctuary and Kuldiha Wildlife Sanctuary are buffer areas. • It includes Joranda and Barehipani Falls. • It is also an important Elephant & Tiger reserve. • It is part of MAB program of UNESCO
Achanakamar-Amarkantak Biosphere Reserve	Covers parts of Anuppur & Dindori districts of MP and parts of Bilaspur districts of Chhattisgarh State	Narmada, Son, and Johila	Tropical monsoon climate, with heavy rainfall (1,200mm to 2,000mm) and temperature range of 5°C to 47°C.	Tropical moist deciduous forests and bamboo brakes	Bengal tiger, Indian bison, Indian leopard, four-horned antelope	• It includes Achanakmar Tiger Reserve, Maikal range. • Amarkantak is source origin of Narmada, Son Rivers and Johila river. • It is part of MAB program of UNESCO
Great Nicobar Biosphere Reserve	Southernmost islands of Andaman & Nicobar Islands	Galathea, Alexandra, Amrit Kaur, and Campbell Bay	Tropical climate, with high humidity and heavy rainfall (3,000mm to 3,500mm) and temperature range of 23°C to 31°C.	Tropical evergreen forests and mangroves	Nicobar megapode, Nicobar pigeon, saltwater crocodile, reticulated python	• It consists of around 85% of the island of Great Nicobar. • It is part of MAB program of UNESCO • *The Campbell Bay National Park is located on the northern part of the island, whereas, Galathea National Park in the southern interior.*

Biosphere Reserve	Location	Rivers that pass through	Climate	Vegetation	Fauna	Other Important Facts
Khangchendzonga Biosphere Reserve	Parts of Khangchendzonga Hills, Sikkim	Teesta, Rangit, and Kanaka	Subarctic climate, with heavy snowfall and temperature range of -10°C to 10°C. Annual rainfall ranges from 3,500mm to 7,000mm.	Alpine and sub-alpine forests, meadows, and glaciers	Snow leopard, red panda, Himalayan tahr, musk deer	• The KhangchendzongNational Park forms the core area of the reserve. • The Tholung Monastery is present in the buffer area of the reserve. • It is a UNESCO World Heritage site. • It is part of MAB program of UNESCO
Agasthyamalai Biosphere Reserve	Neyyar, Peppara and Shendurney Wildlife Sanctuaries and their adjoining areas in Kerala.	Kallar, Thamirabarani, Neyyar	Tropical and subtropical mountainous climate, with heavy rainfall (2,000mm to 4,000mm) and temperature range of 16°C to 35°C.	Tropical evergreen and semi-evergreen forests, grasslands, and swamps	Asian elephant, Bengal tiger, Nilgiri tahr, lion-tailed macaque	• It is located in the Agastya Mala mountain, which heights 1868 metres. • This reserve is also home to one of the oldest surviving tribes in the world- the Kanikaran tribe. • It is part of MAB program of UNESCO
Manas Biosphere Reserve	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamprup and Darang districts (Assam)	Manas and Beki	Subtropical monsoon climate, with high humidity and heavy rainfall (2,500mm to 4,000mm) and temperature range of 15°C to 35°C.	Tropical semi-evergreen and deciduous forests, grasslands, and wetlands	Indian rhinoceros, Bengal tiger, pygmy hog, hoolock gibbon	• The Manas National Park forms the core area of the reserve. • It is an important Project Tiger Reserve and an Elephant Reserve. • It derives its name from the Manas River, which is the tributary of the Brahmaputra River.
Dibru-Saikhowa Biosphere Reserve	Part of Dibrugarh and Tinsukia districts, Assam	Brahmaputra and Lohit	Humid subtropical climate, with heavy rainfall (2,000mm to 3,500mm) and temperature range of 10°C to 35°C.	Tropical semi-evergreen and deciduous forests, grasslands, and wetlands	Feral horses, water buffalo, Gangetic dolphin, black-breasted parrotbill	• It is the smallest biosphere reserve of India. • The Dibru-Saikhowa National Park forms the core area of the reserve. • The Brahmaputra and Lohit Rivers flow in the north and the Dibru River in the south of this reserve. • Important habitat for the golden langur.
Kachchh Biosphere Reserve	Part of Kachchh, Rajkot, Surendra Nagar and Patan Civil Districts of Gujarat	Luni, Rupen, and Kankawati	Arid and semi-arid climate, with low rainfall (300mm to 500mm) and temperature range of 0°C to 50°C.	Desert vegetation, mangroves, and thorn forests	Indian wild ass, Indian wolf, desert fox, chinkara	• It is the largest Biosphere reserve in India. • It covers the Kutch Desert. • It consists of a Sanctuary in the Great Rann of Kutch and The Wild Ass Sanctuary in the Little Rann of Kutch. • It also covers Banni grassland. • It is part of MAB program of UNESCO

Biosphere Reserve	Location	Rivers that pass through	Climate	Vegetation	Fauna	Other Important Facts
Cold Desert Biosphere Reserve	Pin Valley National Park and surroundings; Chandratal and Sarchu & Kibber Wildlife Sanctuary in Himachal Pradesh	Indus and its tributaries	Cold desert climate, with low rainfall (50mm to 100mm) and temperature range of -30°C to 25°C.	Cold desert scrub, alpine and sub-alpine meadows, and dry alpine scrub	Snow leopard, Tibetan wolf, Himalayan ibex, Himalayan brown bear	• The Pin Valley National Park forms the core area of the reserve. • Whereas, the Chandratal, Sarchu, and the Kibber Wildlife Sanctuary form the buffer area. • It is an important habitat for the rare snow leopard.
Panna Biosphere Reserve	Part of Panna and Chhatarpur districts in Madhya Pradesh	Ken	Subtropical climate, with moderate rainfall (1,000mm to 1,500mm) and temperature range of 4°C to 45°C.	Tropical dry deciduous and mixed forests, grasslands, and gorges	Bengal tiger, Indian leopard, Indian wolf, chital	• It consists of the Panna National Park and the Ken Gharial Wildlife Sanctuary. • It lies within the narrow belt of the Vindhyan Hill Ranges. • It is also home to the Gond tribe. • Affected by Ken-Betwa river interlinking project. • It is part of MAB program of UNESCO
Dehang-Debang	Part of Siang and Dibang Valley in Arunachal Pradesh	Dehang and Dibang	Humid subtropical climate, with heavy rainfall (2,000mm to 3,500mm) and temperature range of 5°C to 40°C.	Alpine and sub-tropical forests and meadows	Clouded leopard, Asiatic black bear, Mishmi takin, red goral	• The Mouling National Park form the core area. • The Dibang Wildlife Sanctuary is the buffer area. • It is also home to several indigenous tribes, such as Miji, Aka, and Sherdukpen. • It derives its name from the two rivers that flow through it.
Seshachalam Hills	Seshachalam Hill Ranges covering parts of Chittoor and Kadapa districts of Andhra Pradesh	Papagni and Swarnamukhi	Tropical monsoon climate, with moderate to heavy rainfall (700mm to 1,500mm) and temperature range of 20°C to 40°C.	Tropical dry deciduous forests, grasslands, and shrublands	Slender loris, Indian pangolin, Indian giant squirrel, jungle cat	• It consists of Sri Venkateswara National Park. • The reserve is also home to several important pilgrimage sites, including the Sri Venkateswara Temple in Tirumala. • The area is an important watershed and is the source of several major rivers, including the Pennar, the Palar, and the Swarnamukhi.

Comparison between Wildlife Sanctuaries, National Parks and Biosphere Reserves

Wildlife Sanctuaries	National Parks	Biosphere Reserves
Established for protection of wildlife; they are generally species oriented	Protection of entire ecosystem (plants and animals); also protects historical objects.	Protects entire biodiversity and aims at sustainable development.
No fixed boundaries	Fixed boundaries	Fixed boundaries
Governed under Wildlife Protection Act	Governed under Wildlife Protection Act	Internationally recognized within the framework of UNESCO's MAB programme and nominated by national governments
Can be upgraded to a National Park	Cannot be downgraded to wildlife sanctuary	Wildlife sanctuaries and national parks can be a part of a larger biosphere reserve
Less degree of protection	Greater degree of protection	Greater degree of protection
Human activities are allowed to an extent.	Human activities like grazing, forestry, cultivation is strictly prohibited.	Sustainable Human activities allowed in buffer and transition zone
Corresponds to Category IV of IUCN Protected Areas classification	Corresponds to Category II of IUCN Protected Areas classification	Roughly corresponds to Category V of IUCN Protected Areas classification

Sacred Groves

Sacred groves, also known as sacred forests are areas of forest that are protected and preserved by local communities due to their religious, cultural, and ecological significance.

Significance of Sacred Groves

- **Ecological Significance**
  - **Biodiversity Conservation**: The sacred groves are important habitats for a wide range of plant and animal species that have been conserved by local communities in a sustainable manner.
  - **Water Conservation**: The sacred groves are often associated with ponds, streams or springs, which provide for water to the local community. The vegetation in these groves helps in recharging aquifers and maintaining water availability.
  - **Soil conservation** - The vegetation cover of the sacred groves enhancing the soil stability and preventing soil erosion in the area.
- **Socio-Cultural Significance**
  - **Religious and Cultural Importance:** Sacred groves hold religious and cultural significance for local communities and often associated with deities or ancestral spirits.
  - **Preservation of Traditional Knowledge:** Sacred groves act as repositories of traditional knowledge. They help in preserve indigenous knowledge about the local ecosystem, medicinal plants, and sustainable practices.

Distribution of Sacred Groves in India: In India, Sacred Groves are found all over the country and abundantly along the Western Ghats. According to some studies, the total number of sacred groves in India could be in the range of 100,000 – 150,000.

State-wise Number of Documented Sacred Groves

State	Local term for Sacred Forests	No. of documented Sacred Forests
Andhra Pradesh	Pavithravana	677
Arunachal Pradesh	Gumpa Forests (Sacred Groves attached to Buddhist monasteries)	159
Assam	Sacred Grove	29
Bihar	Sarhuli Mander	43
Chhattisgarh	Matagudi	63
Goa	Deorai, Pann	93
Gujarat	Sabar kantha, Dahod, Banas kantha	42
Haryana	Gurudwara grove	57

State	Local term for Sacred Forests	No. of documented Sacred Forests
Himachal Pradesh	Kul Deveta	329
Jammu& Kashmir	Bani	92
Jharkhand	Sarana/Jaherthan	29
Karnataka	Devara Vana, Devara Kadu, Huli devarakadu, Nagavan, Bhatappavana, Jatakappan bana, Ghowdibana, Kan	1476
Kerala	Kavu, Sarp Kavu	1096
Madhya Pradesh	Sharana, Devkot, Matikot, Devsthali, Budhadev	170
Maharashtra	Pavithravan, Deovan, Deorai, Devgudi, Pen Gada / Gonds, Devarahati	2820
Manipur	Gamkhap, Mauhak (sacred bamboo reserves)	166
Meghalaya	Ki Law Lyngdoh, Ki Law Kyntang, Ki Law Niam	105
Odisha	Jahera, Thakuramma	188
Puducherry	Kovil Kadu	108
Rajasthan	Vani, Malvan, Kenkri, Orans, Shamlat deh, Devabani, Jogmaya	560
Sikkim	Pandam	16
Tamil Nadu	Swami Shola, Koil Kadu, Katttu Koil, Vanakkoil	1275
Telangana	Pavithravana	57
Uttarakhand	Deo Bhumi, Bugyal (sacred alpine meadows)	133
Uttar Pradesh	Dev van,Pavithravan	32
West Bengal	Gramthan, Santalburitan Shitalatan, Haritan Sabitritan, Jahera, Deo Tasara, Mawmund	562

Threats to Sacred Groves in India

- **Changes in traditional belief system:** With increasing modernization, many communities are abandoning their traditional beliefs and practices, and the rituals are considered mere superstitions.
- **Sanskritization:** It has led to the transformation of the primitive nature worship into formal temple worship.
- **Changes in Land use:** With increase in urbanization and agricultural activities, the groves are being encroached upon and cleared for human settlements, agriculture and developmental activities.
- **Overexploitation of resources:** There is an increasing pressure on the sacred groves due to overexploitation of timber, non-timber products. Overgrazing has also become a major issue.
- **Invasion of alien species:** Invasion by exotic weeds such as Eupatorium odoratum, Lantana camara and Prosopis have threatened many sacred groves.

Eco-Sensitive Zones

ESZ are ecologically important and fragile areas around protected areas which are designated to safeguard fragile ecosystems, wildlife habitats, and areas of critical ecological importance from various anthropogenic activities. They act as **insulating layers** where humans and nature can be at peace with each other. As of 2023, 341 ESZs have been notified, while another 85 ESZs are awaiting notification. Together, protected areas and the ESZs cover 8.66% of India's land area.

- **Aim:**
  - To act as shock absorbers for the protected areas, to minimize the negative impact on the "fragile ecosystems" by anthropogenic activities.
  - To act as a transition zone from areas requiring higher protection to those requiring lesser protection.
- **Regulation:** Eco-sensitive zones are notified by the Ministry of Environment, Forest and Climate Change (MoEFCC), under Environment Protection Act, 1986.

  - **2011 Guidelines for declaration of ESZ**: Deals with the process and procedures to be adopted for declaring ESZ.
  - **Other Statutory Provisions related to declaration of ESZs**: Wildlife (Protection) Act, 1972, Environment (Protection) Act 1986 (EPA), Environment (Protection) Rules, 1986 (EPR)
- **Procedure for ESZ Declaration**:
  - **Creation of Inventory**: Data is collected from each of the protected areas with the help of range officers.
  - **Constitution of Committee**: A committee comprising of Wildlife Warden, an ecologist, and an official from the local government is formed. The committee creates a master plan and demarcates the extent of ESZ.
  - **Notification of ESZ**: Final proposal forwarded to MoEFCC and ESZ notified.
- **Extent of ESZs**:
  - Generally, the width of the ESZ could go up to 10 kms around a Protected area (PA) as provided in the Wildlife Conservation Strategy-2002.
  - Sensitive corridors, connectivity and ecologically important patches, crucial for landscape linkages, even beyond 10 kms width, are also included in the ESZ.
- **Categories of activities in ESZ:**

Categories of activities in ESZ:	
Prohibited	Commercial mining Setting of saw mills Setting of industries causing pollution (water, air, soil, noise etc.) Commercial use of firewood Establishment of major hydroelectric projects Use or production of any hazardous substances Undertaking activities related to tourism like over-flying the National Park area by any aircraft, hot-air balloons Discharge of effluent and solid waste in natural water bodies or terrestrial area
Regulated	Felling of trees Establishment of hotels Drastic change of agriculture systems Commercial use of natural water resources including ground water harvesting – Erection of electrical cables – Promote underground cabling Fencing of premises of hotels and lodges Use of polythene bags by shopkeepers Widening of roads Movement of vehicular traffic at night Introduction of exotic species Protection of hill slopes and river banks Air and vehicular pollution Sign boards & hoardings
Permissible	Ongoing agriculture and horticulture practices by local communities Rain water harvesting Organic farming Use of renewable energy sources Adoption of green technology for all activities

- **Monitoring of ESZs:** State government sets a monitoring committee for each ESZ. The committee is headed by the District Collector as the chairperson and a representative of the Forest Department as its member-secretary. It also includes various representatives, from State departments, NGOs and other experts. The committee is required to report the actions taken to the Chief Wildlife Warden every year.

Recent Development

The Supreme Court, in the TN Godavarman Thirumalpad v/s Union of India case, held that every protected forest, national park and wildlife sanctuary in the country should mandatorily have a minimum 1 km ESZ, from their demarcated boundaries.

Key Highlights of Judgement

- Extended boundary shall prevail if the existing ESZ goes beyond 1 km buffer zone or if any statutory instrument prescribes a higher limit.
- **No new permanent structure** will be allowed within the ESZ.
- **Mining** within national wildlife sanctuaries or national parks is **not permitted.**
- The Principal Chief Conservator of Forests of each State/UT has been directed to make a list of subsisting structures at the ESZs and submit a report to the court within 3 months.
- Requirements **could be diluted** if there is overwhelming public interest.

Biodiversity Heritage Sites

These are areas that are unique, ecologically fragile ecosystems having rich biodiversity. Under Biological Diversity Act, 2002, the State Government in consultation with local bodies may notify areas of biodiversity importance as Biodiversity Heritage Sites (BHS). The State Government in consultation with the Central Government also frame rules for the management and conservation of BHS. As of April 2023, there are 40 Biodiversity Heritage Sites in India.

Criteria for Declaration: Areas having any of the following characteristics, may qualify for inclusion as BHS

- Containing a mosaic of natural, semi-natural, and man-made habitats, which together contain a significant diversity of life forms.
- Containing significant domesticated biodiversity component and/or representative agro-ecosystems
- Areas that are significant from a biodiversity point of view as also important cultural spaces such as sacred groves/trees and sites, or other large community conserved areas.
- Areas offering refuge or corridors for threatened and endemic fauna and flora, such as community conserved areas or urban greens and wetlands.
- Areas that provide habitats, aquatic or terrestrial, for seasonal migrant species for feeding and breeding.
- Areas that are maintained as preservation plots by the research wing of Forest department.
- Medicinal Plant Conservation Areas.

List of Biodiversity Heritage Sites in India

Site	Location	Description
Nallur Tamarind Grove	Karnataka	• It is believed to be a relic of the Chola Dynasty. • The Site covers 54 acres and comprises nearly 300 trees. • The area features unique Shola vegetation and grassland with numerous floral species. • They also possess a lot of medicinal value.
Hogrekan	Karnataka	• Hogrekan is a moderately wooded land featuring dry deciduous vegetation. • It serves as a "Wildlife Corridor" between Kudremukha and Bhadra Wildlife Sanctuary. • It is also adjoined with Yemmedode Tiger Reserve. • It has a unique Shola vegetation and grassland. • Flora species here also have medicinal values.
University of Agricultural Sciences, GKVK Campus, Bengaluru	Karnataka	• It is considered as one of the greenest areas in the city of Bengaluru. • This campus hosts a critical repository of various forms of flora and fauna, including 13 species of mammals, 10 species of reptiles, 165 species of birds, and 530 species of plants.

Site	Location	Description
Ambaraguda	Karnataka	• It is a patch of forest area. • It is Situated between the Sharavathi Wildlife Sanctuary and Someshwara Wildlife Sanctuary. • It is home to Shola vegetation and grasslands.
Glory of Allapalli	Maharashtra	• It is a reserved forest area.
Tonglu BHS under the Darjeeling Forest Division	West Bengal	• It is a Medicinal Plant Conservation Area. • The area is known for its unique alpine and sub-alpine vegetation, • It is home to various wildlife species such as red panda, musk deer, and black bears.
Dhotrey BHS under the Darjeeling Forest Division	West Bengal	• It is also a Medicinal Plant Conservation Area. • Important flora here is Oak, Pine, Maple, Birch, etc. • It is also home to Red Panda, Himalayan Black Bear etc.
Dialong Village	Manipur	• The village is known for its unique living root bridges.
Ameenpur Lake	Telangana	• It is a freshwater lake. • It is home to various bird species such as pelicans, storks, and cormorants.
Majuli	Assam	• Majuli is a river island located in the Brahmaputra River. • It is the world's largest river island. • The island is home to various wildlife species such as tigers, elephants, and rare birds.
Ghariyal Rehabilitation Centre	Uttar Pradesh	• The center is dedicated to the conservation of the endangered Gharial crocodile.
Chilkigarh Kanak Durga	West Bengal	• It is a Sacred Grove site.
Khlaw Kur Syiem Kmielng	Jaintia Hills, Meghalaya	• It is a sacred grove site.
Mandasaru	Odisha	• It is a gorge in the Kandhamal district. • It is a habitat for an impressive variety of 1563 species of plants, animals, and fungi, covering a vast expanse of 528 hectares.
Purvatali Rai	Goa	• It is a sacred grove site.
Naro Hills	Madhya Pradesh	• The hills are covered with lush forests • The region is also important for its cultural and historical significance, with several ancient rock art sites and megalithic structures found in the area.
Patalkot	Madhya Pradesh	• This area is known for its rare flora and fauna, including Bryophytes and Pteridophytes, that are not commonly found elsewhere.
Asramam	Kerala	• It is home to a remarkable variety of mangrove species and other species of flora and fauna. • The area boasts 15 species of true mangroves and 22 species of associated mangroves. • Apart, it is also home to 122 plant species, 34 edible fish species, and about 62 bird species. • Of particular importance, the site contains rare and endangered heritage trees of Syzygium travancoricum, which is classified as critically endangered in the IUCN Red List.
Bambarde Myristica Swamps	Maharashtra	• It is a swampy area. • Home to rare and endemic species of plants, such as Myristica swamps, • In terms of fauna, it hosts the endangered Malabar Pied Hornbill and the Malabar Giant Squirrel.

Site	Location	Description
Ganeshkhind Garden	Maharashtra	• It is a botanical garden. • It is home to over 300 species of plants, including medicinal plants, and ornamental plants. • It also hosts rare species like the Buddha Coconut Palm and the Baobab Tree.
Landorkhori	Maharashtra	• It is home to Bhojpatra trees
Schistura Hiranyakeshi	Maharashtra	• The Western Ghats region of Maharashtra has discovered a new fish species named Schistura Hiranyakeshi in a pond at the Mahadev Temple in the Sindhudurg district. • As a result, the 2.11-hectare area surrounding the pond has been designated as a Biological Heritage Site in April 2021, • It is the fifth heritage site of its kind in the Maharashtra.
Baneswar Shiva Dighi	West Bengal	• It is a water body in the Coochbehar area. • The Black Softshell Turtle is found here.
Sacred Grove at Sural Bhatori Monastery	Himachal Pradesh	• The area boasts a unique stand of Betula utilis or Bhojpatra trees • Dominated by shrubs and herbs including Rosa species, Lonicera species, Sorbus species, and Agropyron longearistatum. • The surrounding area supports major faunal species such as the Snow Leopard, Brown Bear, Tibetan Wolf, and Ibex.
High Altitude Meadow	Himachal Pradesh	• It is an alpine pasture land. • The area is characterized by a variety of plant species, including Cotoneaster, Lonicera, Sorbus, Brachypodium sylvaticum, and Primula denticulata. • Additionally, the area is known for its diverse wildlife, including Snow Leopards, Brown and Black Bears, Tibetan Wolves, Himalayan Marmots, Ibex, and Royle's Pika.
Birch-pine Forest Patch	Himachal Pradesh	• The patch features a unique assemblage of trees, including Himalayan Birch and Blue Pine, interspersed with a few middle-aged trees of West Himalayan Spruce, Deodar, and Juniper. • The site also boasts Willow and Sea Buckthorn. • It supports a diverse population of important medicinal and aromatic plants, such as Picrorhiza kurroa, Dactylorhiza haragirea, etc,
Baramura Waterfall	Tripura	• This site boasts the highest natural waterfall in Tripura • It serves as a critical habitat for rare wildlife in the state.
Unakoti	Tripura	• This site has cultural and religious significance, exemplifying ethnoreligious aspects with sacred trees and stones. • It boasts a rich diversity of forest flora and fauna, and the natural stream flow provides diverse ecosystem services. • It is also a site of semi-wild, wild, and domesticated ornamental plants.
Silachari Caves	Tripura	• This site is the sole natural cave in Tripura. • It serves as a unique habitat for numerous endangered cave bat species.
Debbari or Chabimura	Tripura	• It is a river forest ecosystem • It is a unique habitat for threatened plants of Tripura such as the Dhup tree and important cane resources of India. • In addition, the region provides a unique breeding habitat for threatened fishes
Betlingshib & its surroundings	Tripura	• It is the highest peak in Tripura. • This peak holds significant biodiversity, with the highest floristic diversity in Tripura, • The vegetation in this region is distinctly different from the mainland due to changes in altitude, topography, and climate.

Site	Location	Description
Amarkantak	Madhya Pradesh	• The site is located on the Maikal mountain range. • It has a unique ecosystem, that is estimated to be around 6 million years old. • It is home to various rare species of flora and fauna, including Bryophytes and Pteridophytes. • The Amarkantak ecological system is the source of three major rivers- the Narmada River, the Son River, and the Johila River.
Hajong Tortoise Lake	Assam	• It is a natural habitat for several endangered and critically endangered species, such as the Black Softshell turtle and the Indian Peacock Softshell turtle. • The site is also home to threatened species like the Chinese Pangolin (critically endangered), the Clouded Leopard, Leopard, Asiatic Black Bear, Fishing Cat, Sambar, etc.
Borjuli Wild Rice Site	Assam	• It stands out for its significant population of the wild rice species Oryza rufipogon, which is vulnerable to both climate change and human activity. • O. rufipogon possesses genes that provide resistance to pests and diseases, as well as tolerance to submergence and salinity, making it a valuable resource for breeding and improving rice crops. • O. rufipogon is photosensitive and flowers during the short days of November and December. • Its seeds have a tendency to shatter upon maturation, and it can tolerate flooding and acidic soils.
Arittapatti Biodiversity Heritage Site	Tamil Nadu	• It boasts rich biological and historical significance, with the presence of approximately 250 bird species, including three notable raptor species: the Laggar Falcon, Shaheen Falcon, and Bonelli's Eagle. • The site also hosts diverse wildlife, such as the Indian Pangolin, Python, and Slender Loris.
Mahendragiri Hill Biodiversity Heritage Site	Odisha	• It exhibits various microclimates, ranging from tropical shola to tropical dry deciduous as the altitude increases. • It represents 40% of the reported flora of Odisha, including a total of 1,358 plant species. • Additionally, the ancient temples of Kunti, Shima, Arjuna, and Yudhisthir located at Mahendragiri have been recognized as protected monuments under the Ancient Monument and Archaeological Sites and Remains Act 1958 by the State Government.
Char Balidanga	West Bengal	• It is a small island on the Ganges River. • It has tropical riverine-type vegetation, characterized by the presence of tall grasses and trees. • The island also has areas of swampy flat land covered with mats of algae. • The island has several temples and monuments, including the Char Bangla temple complex and the Hazarduari Palace.
Namthing Pokhari	West Bengal	• It is a natural Himalayan wetland. • It is surrounded by lush green forests and hills, making it a popular tourist destination. • It is also home to the Himalayan salamander.
Amkhoi Wood Fossil Park	West Bengal	• It is a unique park that showcases a collection of petrified wood fossils, some of which are millions of years old. • Visitors can learn about the history of the fossilized trees and how they were formed, as well as explore the beautiful natural surroundings of the park.
State Horticulture Research and Development Station	West Bengal	• It is a research facility focused on the development of new and improved horticultural techniques and crops. • It also hosts indigenous horticulture germplasm of orchard trees.

Natural World Heritage Sites in India

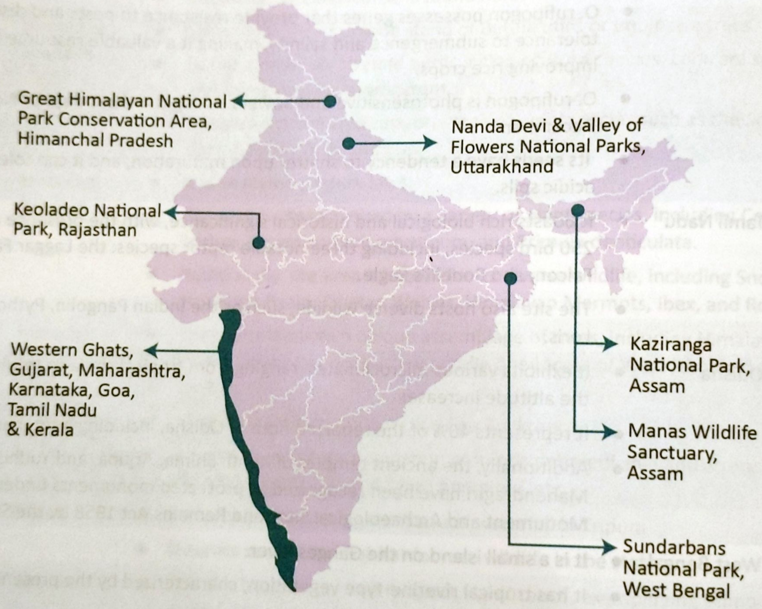
World Heritage Sites are places recognized and protected by the United Nations Educational, Scientific and Cultural Organization (UNESCO). These sites represent world's most significant natural and cultural heritage. The sites can be natural, cultural, or a combination of both.

Once a site is inscribed on the World Heritage List, it receives legal protection under the international law. The countries housing these sites are responsible for their preservation. They are further encouraged to develop management plans in order to safeguard their exceptional universal value for future generations.

List of Natural World Heritage Sites in India

As of 2023, there are 40 World Heritage Sites in India which includes 7 Natural World Heritage Sites, 32 Cultural World Heritage Sites and 1 Mixed World Heritage Site (Khangchendzonga National Park, Sikkim), in India.

World Natural Heritage Sites in India


Great Himalayan National Park Conservation Area, Himanchal Pradesh
Nanda Devi & Valley of Flowers National Parks, Uttarakhand
Keoladeo National Park, Rajasthan
Western Ghats, Gujarat, Maharashtra, Karnataka, Goa, Tamil Nadu & Kerala
Kaziranga National Park, Assam
Manas Wildlife Sanctuary, Assam
Sundarbans National Park, West Bengal

World Natural Heritage Sites in India

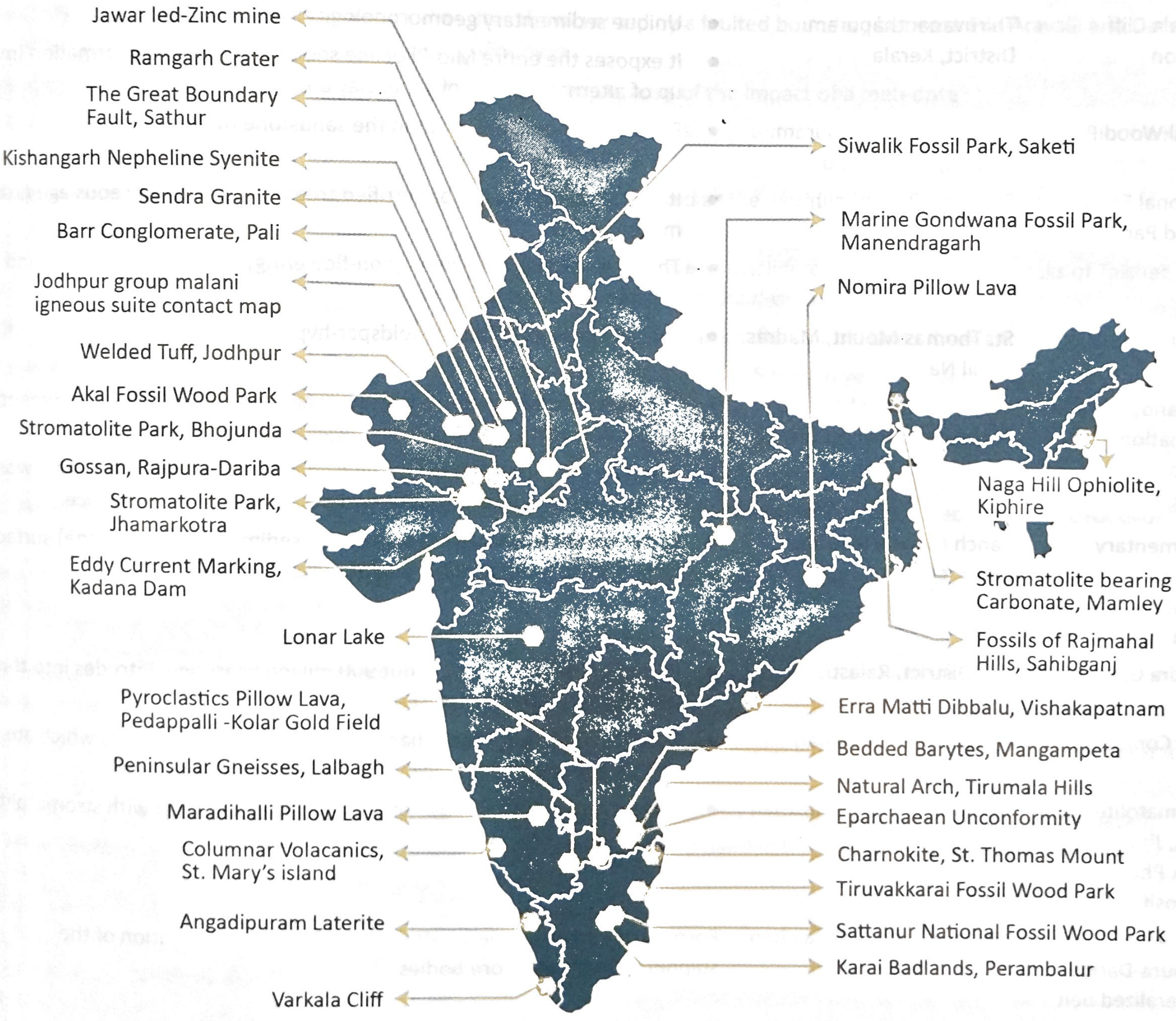
Site	Location	Description
Great Himalayan National Park Conservation Area	Western Himalayas, Himachal Pradesh	• Characterized by high alpine peaks, alpine meadows and riverine forests • Source of Jiwa Nal, Sainj, Tirthan and Parvati River. • Home to several endangered species such as the western tragopan, Himalayan tahr, and musk deer.
Western Ghats	Karnataka, Kerala, Maharashtra, Tamil Nadu	• Recognized as one of the world's eight 'hottest hotspots' of biological diversity along with Sri Lanka • Includes best representatives of non-equatorial tropical evergreen forests • Home to at least 325 globally threatened flora, fauna, bird, amphibian, reptile and fish species
Nanda Devi and Valley of Flowers National Parks	Western Himalayas, Uttarakhand	• Home to several endemic and endangered species such as the Himalayan musk deer, snow leopard, and Asiatic black bear.

Site	Location	Description
Sundarbans National Park	Sundarbans Delta region, West Bengal	• Contains the World's largest area of mangrove forests • Home to several endangered species such as the Bengal tiger, saltwater crocodile, and Indian python.
Kaziranga National Park	Assam	• Inhabited by the world's largest population of One-horned rhinoceros. • Important area for migratory birds
Keoladeo National Park	Rajasthan	• Major wintering areas for migratory birds like Siberian Crane
Manas Wildlife Sanctuary	Assam	• Home to several endangered species such as the pygmy hog, golden langur, and hispid hare.

Geological Heritage Sites

Geological Heritage Sites or Geo-heritage Sites are geological areas of scientific, cultural and educational value. These sites have unique geological, geomorphological, mineralogical, petrological, paleontological and stratigraphic significance including caves, natural rock-sculptures of national and international interest.

Regulation and Management: Geological Survey of India, under Ministry of Mines, recognizes, declares and maintains the geo-heritage sites in India.


Jawar led-Zinc mine
Ramgarh Crater
The Great Boundary Fault, Sathur
Kishangarh Nepheline Syenite
Sendra Granite
Barr Conglomerate, Pali
Jodhpur group malani igneous suite contact map
Welded Tuff, Jodhpur
Akal Fossil Wood Park
Stromatolite Park, Bhojunda
Gossan, Rajpura-Dariba
Stromatolite Park, Jhamarkotra
Eddy Current Marking, Kadana Dam
Lonar Lake
Pyroclastics Pillow Lava, Pedappalli -Kolar Gold Field
Peninsular Gneisses, Lalbagh
Maradihalli Pillow Lava
Columnar Volacanics, St. Mary's island
Angadipuram Laterite
Varkala Cliff
Siwalik Fossil Park, Saketi
Marine Gondwana Fossil Park, Manendragarh
Nomira Pillow Lava
Naga Hill Ophiolite, Kiphire
Stromatolite bearing Carbonate, Mamley
Fossils of Rajmahal Hills, Sahibganj
Erra Matti Dibbalu, Vishakapatnam
Bedded Barytes, Mangampeta
Natural Arch, Tirumala Hills
Eparchaean Unconformity
Charnokite, St. Thomas Mount
Tiruvakkarai Fossil Wood Park
Sattanur National Fossil Wood Park
Karai Badlands, Perambalur

Geo-heritage Sites in India

List of Geological Heritage Sites in India

As of 2023, there are 34 geological heritage sites in India.

Geo-heritage Site	Location	Description
Volcanogenic bedded Barytes	Mangampeta, Cuddapa District, Andhra Pradesh	• Formed through the precipitation from volcanic vapors under submarine conditions and sub aerial showering of ash and molten barite lapilli. • One of the largest barite deposits of the world.
Eparchaean Unconformity	Namalagundu, Anantpur District, Andhra Pradesh	• The boundary between the Proterozoic Nagari Quartzite and Archaean Granites which denotes enormous time gap in the evolution of earth's crust • It is indicated by the occurrence of conglomerate.
Natural Geological Arch	Tirumala Hills, Chittoor District, Andhra Pradesh	• Carved out of quartzite of Cuddappah Supergroup of Middle to Upper Proterozoic (1600 to 570 Ma) by collective action of weathering agents like wind and water over a long period of several thousands of years.
Erra Matti Dibbalu	Vishakhapatnam, Andhra Pradesh	• Towering red sand dunes • The sediments of red sand dunes are derived from the Khondalite rocks
Laterite	Angadipuram, Malapuram District, Kerala	• Derived from acid charnockite
Varkala Cliff Section	Thiruvananthapuram District, Kerala	• Unique sedimentary geomorphological structure • It exposes the entire Mio-Pliocene sequence of Warkalli formation (made up of alternating beds of sand, clay and shale)
Fossil Wood Park	Tiruvakkarai, Villupuram District, Tamil Nadu	• Fossilized tree trunks occur in the sandstone mounds.
National Fossil Wood Park	Sattanur, Perambalur District, Tamil Nadu	• It contains large trunks of petrified trees of Upper Cretaceous age (100 million years). • The trees belong to conifers (non-flowering) that dominated the land vegetation during the period.
Charnockite	St. Thomas Mount, Madras, Tamil Nadu	• Typical exposure of quartz-feldspar-hypersthene rock
Badlands of Karai Formation with Cretaceous fossils along Karai	Kulakkalnattam Section, Perambalur District, Tamil Nadu	• The Karai Formation forms the lower part of the Cretaceous sedimentary succession of the Cauvery basin. • A variety of marine fossils like ammonites, belemnites, nautiloids, worm tubes, pelecypods, gastropods and oysters occur in abundance.
Sedimentary Structures Eddy Markings, Kadan Dam	Panch Mahals District, Gujarat	• Eddy Current Markings are exposed in sedimentary (sandstone) surface of Upper Aravalli Lunavada Group of rocks.
Sendra Granite	Pali District, Rajasthan	• Plutonic igneous rock of about 900 million years ago, intrudes into the Delhi Supergroup of metasedimentary rocks.
Barr Conglomerate	Pali District, Rajasthan	• Composed of pebbles of quartzite and rarely granite gneiss which are set up in a fine-grained politic matrix.
Stromatolite Fossil Park, Jharmarkotra Rock Phosphate Deposit	Udaipur District, Rajasthan	• Largest and richest deposit of phosphorite associated with stromatolite.
Gossan in Rajpura-Dariba Mineralized belt	Udaipur District, Rajasthan	Formed due to excessive weathering and pervasive oxidation of the sulphides-sulphosalts ore bodies

Geo-heritage Site	Location	Description
Stromatolite Park	Bhojunda, Chittaurgarh District, Rajasthan	• Stromatolites are structures which are produced by blue-green algae, which through their filaments, attract and bond carbonate particles forming a mat. • Stromatolite Park is an exposure within the massive Bhagwanpura Limestone of the Lower Vindhyan age.
Akal Fossil Wood Park	Jaisalmer District, Rajasthan	• Contains about a dozen fossil wood logs lying horizontal in random orientation. • The fossils are of petrophyllum, ptyllophyllum, equisetitis species and dicotyledonous wood and gastropod shells of Lower Jurassic period
Kishangarh Nepheline Syenite	Ajmer District, Rajasthan	• It is a pluton emplaced along the core of an antiform of metamorphites in Aravalli craton of Rajasthan.
Welded Tuff	Jodhpur District, Rajasthan	• The welded tuff had escaped out from volcanic vents and was carried away by air to settle down. • They are composed of glass, quartz and feldspar.
Jodhpur Group-Malani Igneous Suite Contact	Jodhpur District, Rajasthan	• The igneous suite marks the last phase of igneous activity of Precambrian age in the Indian Subcontinent.
Great Boundary Fault at Satur	Bundi District, Rajasthan	• It is characterized by a faulted boundary between Pre-Aravalli and Upper Vindhyan.
Ramgarh Crater	Baran District, Rajasthan	• It is formed because of the impact of a meteorite. • The meteor impact has created a lake of almost 3 km diameter in the Kota plateau.
Zawar lead-zinc mine	Udaipur District, Rajasthan	• It has been recognized as the world's first zinc smelting site.
Lower Permian Marine bed at Mahendragarh	Sarguja District, Chhattisgarh	• It is a unique exposure of fossiliferous marine Permian rocks of Talcher Formation belonging to Gondwana Supergroup. • Located upstream to the confluence of Hasdo River and Hasia Nala.
Siwalik Fossil Park, Saketi	Sirmur District, Himachal Pradesh	• Contains rich collection of 2.5 million years old vertebrate fossils from Siwaliks.
Pillow Lava in iron ore belt	Nomira, Keonjhar District, Odisha	• It is an exposure of well-preserved pillow structures.
Lonar Lake	Buldana District, Maharashtra	• formed due to impact of a large meteorite on Deccan Basaltic rocks of Cretaceous age.
Columnar Basaltic Lava, St Mary Islands	Udupi District, Karnataka	• Multi-faced columns developed in the basalts of Deccan Trap.
Pillow Lavas near Mardihalli	Chitradurga District, Karnataka	• They are formed due to eruption and solidification of molten lava. It solidified in the form of roughly spherical or rounded pillow shape.
Peninsular Gneiss	Lalbagh, Bangalore, Karnataka	• Comprised of dark biolite gneiss with a composition ranging from granitic to granodioritic
Pyroclastic & Pillow lavas, Kolar Gold Fields	Kolar District, Karnataka	• Set of welded agglomerates of very large fragments of granite, basalt, granite gneiss and also banded ferruginous quartzite all set in a matrix of ignimbrite
Plant Fossil bearing inter-trappean beds of Raajmahal Formation	Upper Gondwana sequence around Mandro, Sahibganj District, Jharkhand	• Fossils belong to the fern, cycads and conifers.

Geo-heritage Site	Location	Description
Stromatolite bearing Dolomite/ Limestone of Buxa Formation	Mamley near Namchi, South District, Sikkim	• Stromatolites are structures which are produced by blue-green algae, which through their filaments, attract and bond carbonate particles forming a mat. • This site provides the example of early life in Sikkim Himalayas.
Nagahill Ophiolite	Site near Pungro, Nagaland	• Ophiolite rocks are a section of the Earth's oceanic crust. • These rocks are usually exposed to above sea level conditions and are often emplaced into continental's crust.

Draft Geo-heritage Sites and Geo-relics (Preservation and Maintenance) Bill, 2022

The Draft Bill aims to establish provisions declaration, preservation, protection and maintenance of geo-heritage and geo-relics of national importance. It also seeks to promote geological studies, education, research, and raising awareness about these resources.

Salient features of the Draft Bill:

- It authorizes the Central Government to declare a geo-heritage site to be of national importance.
- It authorizes the Central Government to acquire area under a geo-heritage site under the provisions of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.
- The Central Government and GSI are mandated to enter and inspect survey, take measurements and samples, undertake exploration operations, examine documents etc.
- It imposes prohibition on construction, reconstruction, repair or renovation of any building within the geo-heritage area or utilization of such in any other manner, except for construction for preservation and maintenance of geo-heritage site or any public work essential to the public.
- It imposes penalties for destruction, removal, defacement or contravention of any direction issued by the Director General, GSI in the geo-heritage site.

EX-SITU CONSERVATION METHODS

Gene Banks

Gene banks are repositories that store and preserve genetic material of various organisms for conservation and future use. They play an important role in safeguarding biodiversity, protecting genetic resources, and supporting scientific research and agricultural development.

Types of Gene Banks

- **Seed Banks**: It is a place to store and preserve seeds of diverse plant species. They are important for maintaining genetic diversity, enabling plant breeding programs, and ensuring food security.

Seed Banks in India

- **Seed Bank Scheme:** The scheme is being implemented by the Seed Division of Ministry of Agriculture from 1999-2000. It aims to meet requirements of seeds during natural calamities and unforeseen conditions. Financial Assistance is provided for the development of necessary infrastructure for construction of seed storage as well as setting up of data bank for facilitating faster flow of information on the availability of seeds.
- **National Gene Bank**: It was established in the year 1996. It aims to preserve the seeds of Plant Genetic Resources for future generations. It has the capacity to preserve about one million germplasm in the form of seeds. In 2021, the world's second-largest refurbished gene bank at the National Bureau of Plant Genetic Resources was established.
- **National Bureau of Plant Genetic Resources (NBPGR):** It was established in 1976 by the Indian Council of Agricultural Research (ICAR) in 1976. It serves as the nodal agency at for management of plant genetic resources (PGR) in India. NBPGR is headquartered at Pusa, New Delhi and has 10 regional stations.
- **The Indian Seed Vault:** Built in 2010, jointly by the Defense Institute of High-Altitude Research and the National Bureau of Plant Genetic Resources, it is a secure seed bank located in a high-altitude mountain pass on the Chang La in Ladakh. It is the second largest seed bank in the world.
- **Private Seed Banks:** Navdanya, a NGO, has established 54 community seed banks across India. Deccan Development Society, a NGO, initiated a community gene bank project to preserve agro-biodiversity.

DO YOU KNOW?

Located in Norway, the **Svalbard Global Seed Vault** is the World's largest secure seed bank.

- **Filed Gene Banks:** These are gene banks for conservation of living plants. They conserve living plants in their natural environment or in controlled conditions, such as botanical gardens, farms, or research institutes. They are important for the preservation of rare and threatened species. They also provide living germplasm for research, and support plant breeding efforts.
- **In-Vitro Gene Banks and Cryopreservation:** These banks utilize tissue culture techniques to grow and maintain plant materials such as cells and embryos, under sterile conditions. Cryopreservation is the process of storing and preserving living systems by freezing them at extremely low temperatures
- **Animal Gene Banks:** These gene banks preserve genetic material from various animal species, including livestock, wildlife, and endangered species. They generally store semen, embryos, or DNA samples. Example: The International Livestock Research Institute's gene bank.
- **Microbial Gene Banks:** These gene banks collect, store, and maintain microorganisms, such as bacteria, fungi, and viruses. The are important in research, industrial applications, and the development of vaccines, antibiotics, and other biotechnological products. Example: World Federation for Culture Collections (WFCC).

Botanical Gardens

Botanical Gardens are the places where plants are grown outdoors or in greenhouses and conservatories.

Significance of Botanical Gardens

- **Conservation of Plant Diversity**: They are the living repositories of diverse plant species and aids in the conservation and preservation of plant genetic resources through ex-situ cultivation, seed banks, and germplasm repositories.
- **Research and Education:** The botanical gardens help in scientific research on plant taxonomy, ecology, and horticulture. They also serve as a platform for botanical studies, breeding of plants, and the development of sustainable agricultural practices.
- **Generating Awareness:** These gardens provide for workshops, exhibitions and help in raising awareness about the importance of biodiversity conservation and the role of plants in ecological balance.
- **Cultural and Recreational Value:** Botanical gardens provide spaces for recreation, and aesthetic appreciation. They also preserve the cultural heritage associated with indigenous plants, traditional uses, and folklore.

Botanical gardens in India

- Botanical gardens in India are regulated and managed by various governmental and non-governmental organizations including universities, research institutes, and local municipal bodies. There are more than 120 botanical gardens in India. Some botanical gardens come under direct control of the Botanical Survey of India.
- Established in 1787, the Acharya Jagadish Chandra Bose Indian Botanic Garden, formerly known as the Calcutta Botanic Garden, is the oldest and largest Botanical Garden in India. It is located in Kolkata and comes under the direct control of the Botanical survey of India.

Zoological Gardens or Zoos

Zoos are facilities where animals are kept for public display, wildlife conservation, education, and research. These facilities help conserve wildlife through captive breeding programs, rescue and rehabilitation of injured or orphaned animals, and promoting public support for wildlife conservation.

Zoos in India

There are 156 recognized zoos in India. Arignar Anna Zoological Park (Vandalur Zoo), established in 1855, is the oldest zoo in India. It is located in Chennai, Tamil Nadu.

Management of Zoos:

The Zoos in India are managed as per the provisions of the Wild Life (Protection) Act, 1972 and guided by the National Zoo Policy, 1998.

- **Central Zoo Authority (CZA)**
- In 1992, the India Government established the Central Zoo under Wildlife (Protection) Act, 1972. It seeks to complement and strengthen the national effort in conservation of the rich biodiversity of the country. The CZA is composed of a chairman, ten members and a Member Secretary.
- **Functions of the CZA:**
  - It is responsible for overseeing the management and operation of zoos in India. Every Zoo in India needs CZA recognition.

- It sets standards and guidelines for the maintenance of animals, enclosures, visitor facilities, and conservation activities within the zoos.
- It also provides technical support, training programs, and financial assistance to improve the functioning of zoos in India.

Examples of successful ex-situ conservation in Indian zoos:

- Breeding of the very rare pygmy hog in Guwahati Zoo.
- Delhi zoo had successfully bred the rare Manipur brow antlered deer.

Eco-Bridges or Eco ducts

Eco Bridges, also known as wildlife corridors or wildlife crossings, serve as connections between two larger areas of wildlife habitat.

Objective: The prime objective of building eco-bridge is to enhance connectivity between the wild life populations that would have been separated by anthropogenic activities. The activities primarily include agricultural activities, infrastructure development, highways and road building.

Features

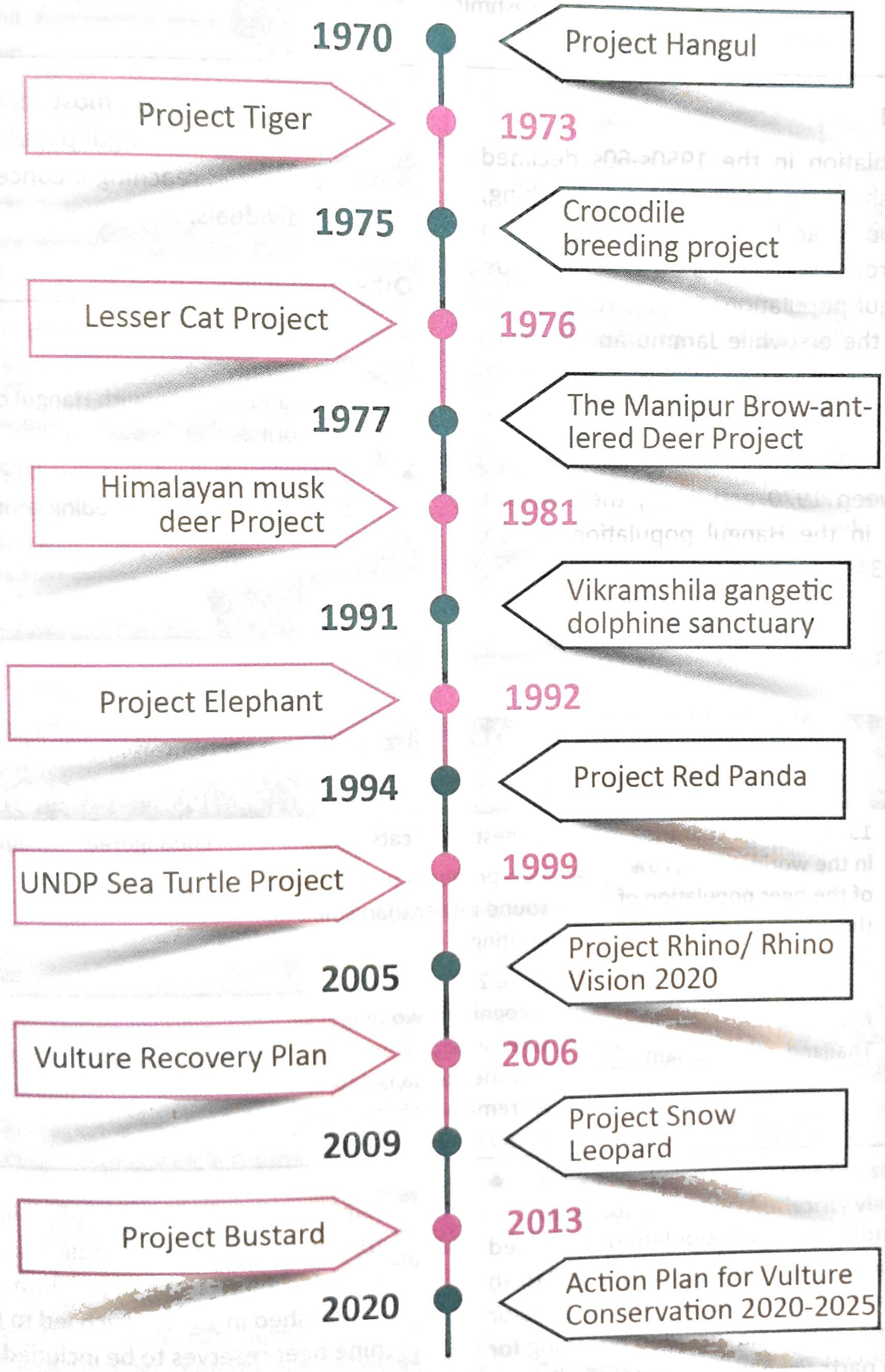
- The eco-bridges are built using the native vegetation which is generally made-up of plants from the native area.
- The native vegetation provides a contiguous look to the landscape.
- The eco-bridges include underpass tunnels, overpasses (mainly for animals associated with large herds like elephants; amphibian tunnels, fish ladders, canopy bridges (for monkeys and squirrels), and culverts for small mammals like otters, hedgehogs, and badgers, and green roofs for butterflies and birds.
- When constructing Eco Bridges, careful consideration is given to their size and location, taking into account the movement patterns of different animal species.

Examples of Eco-bridges in India:

- **Telangana:** Overpass eco-bridge, facilitating convenient and safe movement of wild animals on the Mancherial – Chandrapur route on National Highway 63.
- **Uttarakhand:** Eco bridge across Kaladhungi—Nainital Highway.

CHAPTER 9

SPECIES BASED CONSERVATION PROGRAMMES IN INDIA



Conservation Programmes For Various Species

Project Hangul

About Hangul

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
Hangul	Endemic to India, found in Dachigam National Park, adjoining protected areas in Jammu & Kashmir	• Only surviving species of the Asiatic member of the red deer family. • State animal of erstwhile state (current UT) of Jammu & Kashmir	Critically Endangered	Appendix I	Schedule I

About Project Hangul

The Hangul population in the 1950s-60s declined significantly due to shrinking habitat, illegal poaching, illegal incursion by nomadic herders, and competition for grazing grounds from livestock. To address the issue of declining the hangul population, Project Hangul was launched in 1970 by the erstwhile Jammu and Kashmir governments with the assistance of IUCN and WWF.

- **Aim:** The main aim of Project Hangul is to protect Hangul and its habitat.
- **Evaluation:** Between 1970 and 1980, there was a notable increase in the Hangul population, which rose from 150 to 340 individuals.
- According to the most recent census conducted in 2017, the Hangul population has experienced a decline, reaching a concerning number of 182 individuals.

Other Initiatives

- **In 2010:** The Wildlife Conservation Fund was established with the goal of protecting wildlife and wilderness in Jammu and Kashmir, with Hangul conservation as its first priority.
- **In 2013:** The Kashmir state wildlife department established a captive breeding center in Shikargarh.

Project Tiger

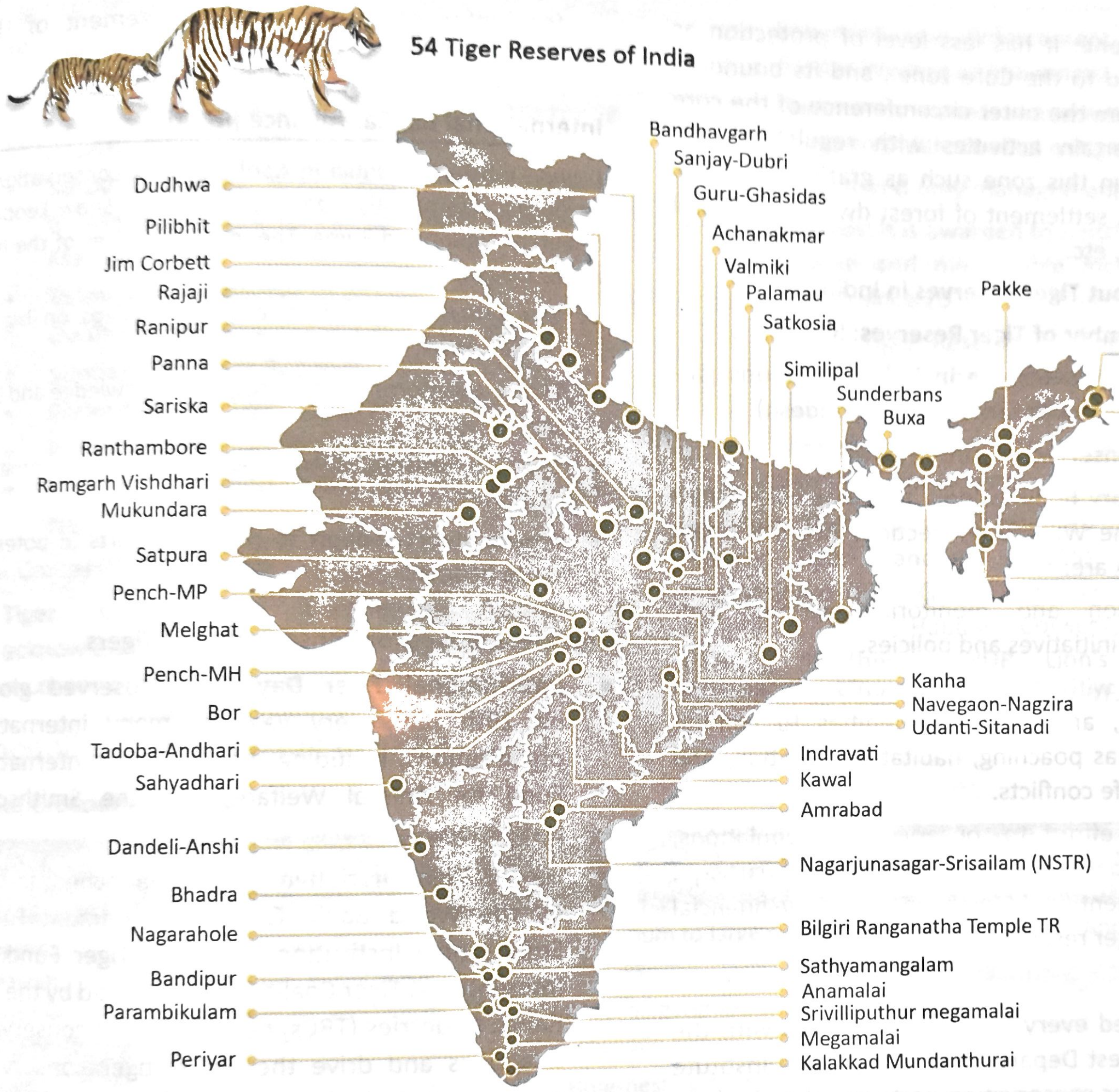
About Tiger

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
Tiger	13 tiger range countries in the world- India (70% of the tiger population of the world), Bangladesh, Bhutan, Cambodia, China, Indonesia, Lao PDR, Malaysia, Nepal, Russia, Thailand, and Vietnam	• Largest of all cats • Rely primarily on sight and sound rather than smell for hunting • Since 2017, IUCN has recognized two tiger subspecies, continental tiger and the Sunda Island tiger. All remaining island tigers are found only in Sumatra.	Endangered	Appendix I	Schedule I

About Project Tiger

- **Background:** In India, the tiger population witnessed a huge decline from an estimated 40,000 in 1900 to an alarmingly low number of 1,800 by 1972. The major threats faced by tigers in India included poaching for the trade in body parts used in traditional medicines, habitat loss, fragmentation, and retaliatory killing following attacks on people and livestock. To tackle the declining tiger population, a task force was established in 1971, which led to the identification of nine tiger reserves to be included in the Project Tiger initiative. Project Tiger was launched in 1973 at the Jim Corbett National Park.

- **Aim:** To promote the conservation of the tiger and tiger habitats.
- **Key Features:**
    - It is a centrally sponsored scheme, which focuses on in-situ tiger conservation through tiger reserves based on a core-buffer strategy.
    - National Tiger Conservation Authority is the nodal agency to implement this project.


54 Tiger Reserves of India

54 Tiger Reserve in India

Tiger Range in India:

- **Western Ghats:** This region includes tiger reserves like Periyar Tiger Reserve in Kerala, Bandipur National Park in Karnataka, and Mudumalai National Park in Tamil Nadu.
- **Eastern Ghats:** This region is home to Simlipal National Park and Bhitarkanika National Park in Odisha.
- **Central India:** This area consists of tiger reserves such as Kanha Tiger Reserve and Pench Tiger Reserve in Madhya Pradesh, Bandhavgarh National Park in Madhya Pradesh, and Tadoba-Andhari Tiger Reserve in Maharashtra.
- **Northeast India:** This region has significant tiger populations and includes tiger reserves like Kaziranga National Park and Manas National Park in Assam, and Sundarbans National Park in West Bengal.
- **Terai Arc Landscape:** This landscape spans across the northern states of Uttarakhand and Uttar Pradesh and includes tiger reserves like Corbett Tiger Reserve, Rajaji National Park, and Dudhwa Tiger Reserve.

Tiger Reserves:

- They are declared and administered by the National Tiger Conservation Authority via Wild Life (Protection) Amendment Act,2006 under Project Tiger.
- They are divided into two zones- namely, Core and Buffer.
    - **Core Zone:** It has the highest level of protection and restrictions to protect its population and

dependent prey. In addition, it has equal legal status as the National Park and Wildlife Sanctuary. Activities such as grazing, forestry operations, and other human activities are strictly prohibited in this zone.

- **Buffer Zone:** It has less level of protection as compared to the Core zone., and its boundary starts from the outer circumference of the core zone. Certain activities with regulations are allowed in this zone such as grazing, scientific research, settlement of forest dwellers, cultural activities, etc.

- **Key Facts about Tiger Reserves in India**
  - **Total Number of Tiger Reserves**: 54
  - **Largest Tiger Reserve in India**: Nagarjunsagar-Srisailam Tiger Reserve (Andhra Pradesh)

National Tiger Conservation Authority (NTCA):

It is a statutory body in India that was established in 2005 under the Wildlife (Protection) Act. The main functions of NTCA are:

- Implementation and monitoring various tiger conservation initiatives and policies.
- Work closely with state governments, conservation organizations, and local communities to combat threats such as poaching, habitat degradation, and human-wildlife conflicts.
- Coordinating efforts to conserve tiger populations, conducting tiger population estimation surveys, promoting scientific research, and providing financial support to tiger reserves.

Tiger Census:

It is conducted **every four years** by NTCA with the help of, State Forest Departments, the Wildlife Institute of India, and other conservation partners. The aim is to monitor and estimate the population of tigers. The first census was conducted in the year 2006.

According to Tiger Census, 2022

- **Total Number of Tigers:** The number of tigers in India was 3,167 in 2022, up from 2,967 in 2018
- The population has grown the most in the Shivalik hills and Gangetic flood plains. However, there has been a decline in the Western Ghats.

M-STrIPES

It is a short form for **Monitoring System for Tigers - Intensive Protection and Ecological Status**. M-STrIPES was launched in 2010 by NTCA. It is a software-based monitoring system designed to improve tiger conservation efforts.

- M-STrIPES utilizes advanced technology, such as camera traps and GPS tracking, to monitor tiger populations, detect poaching activities, and assess habitat conditions.
- **Significance:** It provides real-time information for better protection and management of these magnificent creatures.

International Big Cat Alliance (IBCA)

It was launched by India in April 2023, for conservation of seven big cats namely Tiger, Lion, Leopard, Snow Leopard, Cheetah, Jaguar and Puma. The main objectives of the IBCA are as follows:

- Strengthen global efforts and partnerships on big cat conservation,
- Evolve a platform for convergence of knowledge and best practices,
- Support existing species specific inter-governmental platforms,
- Provide direct support to recovery efforts in potential range habitats.

Global Initiatives for Conservation of Tigers

- **International Tiger Day:** It is observed globally on 29th July every year by many international organizations, including the WWF, the International Fund for Animal Welfare, and the Smithsonian Institution.
- **Global Tiger Initiative:** It was launched in 2008 by the World Bank, Global Environment Facility, Smithsonian Institution, Save the Tiger Fund, and International Tiger Coalition. The GTI, led by the Tiger Range Countries (TRCs) helps carry out conservation strategies and drive the global tiger conservation agenda.
- **The St. Petersburg Declaration on Tiger Conservation:** It is an international commitment aimed at the conservation and protection of wild tigers. It was adopted during the International Tiger Forum held in St. Petersburg, Russia, in 2010.
- **Global Tiger Recovery Programme**: It was endorsed by the Tiger Range Countries (TRCs) in the first Tiger Summit in St Petersburg, Russia. It aims to reverse the rapid decline of wild tigers and strive to double the number of wild tigers (TX2 target) across their range by 2022.
- **Global Tiger Forum**: Established in 1994, it is an inter-governmental international body, which aims at conservation of tiger in the wild along with its prey and habitat. It is headquartered in New Delhi.

- **Conservation Assured Tiger Standards (CATS):** Launched in 2013, it is an accreditation tool by the global coalition of Tiger Range Countries (TRCs). CATS provides a set of criteria and indicators that evaluate the management, planning, and effectiveness of tiger conservation efforts. 14 Tiger Reserves in India have been awarded international CATS accreditation. These include:
  - **Manas, Kaziranga, and Orang Tiger Reserve** in Assam,
  - **Satpura, Kanha,** and **Panna Tiger Reserve** in Madhya Pradesh, **Pench Tiger Reserve** in Maharashtra,
  - **Valmiki Tiger Reserve** in Bihar,
  - **Dudhwa Tiger Reserve** in Uttar Pradesh,
  - **Sunderbans Tiger Reserve** in West Bengal,
  - **Parambikulam Tiger Reserve** in Kerala,
  - **Bandipur Tiger Reserve** of Karnataka
  - **Mudumalai** and **Anamalai Tiger Reserve** in Tamil Nadu.

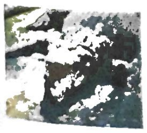
Tiger Conservation Awards

- **Tiger Conservation Excellence Award:** It acknowledges one site that has demonstrated excellence in two or more of these five themes:
  - Tiger and prey population monitoring and research (tiger translocation prey augmentation)
  - Effective site management (CA|TS and Management Effectiveness Tracking Tool (METT) assessments)
  - Enhanced Law Enforcement & protection & Ranger Welfare improvement
  - Community based conservation, benefits and Human-Wildlife conflict mitigation
  - Habitat and prey management
- **TX2 Awards:** It is awarded to a site that has achieved remarkable and measurable increase in its tiger population since 2010.
  - Pench Tiger Reserve in Madhya Pradesh and adjoining Pench Tiger Reserve in Maharashtra have collectively won 2023 TX2 Award The Tiger Conservation Excellence Award was won by Satpura Tiger Reserve

Note: The awards are presented by the Conservation Assured Tiger Standards (CA|TS), Fauna and Flora International (FFI), Global Tiger Forum (GTF), IUCN's Integrated Tiger Habitat Conservation Programme (ITHCP), Panthera, UNDP Lion's Share, Wildlife Conservation Society (WCS) and WWF.

Crocodile Conservation in India

About Crocodiles in India

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
Mugger or Marsh Crocodile 	India, Sri Lanka, Pakistan, Nepal and possibly, in Bangladesh, its range extends westwards into eastern Iran	• A medium to large crocodilian species • Most alligator like of all crocodile species • Hole-nesting species, with egg-laying taking place during the annual dry season.	Vulnerable	Appendix I	Schedule I
Estuarine or saltwater crocodile 	Odisha's Bhitarkanika National Park, the Sundarbans in West Bengal, and the Andamans and the Nicobar Islands. It is also found across Southeast Asia and northern Australia.	• Largest of all crocodile species • Reputation of being a man-eater	Least Concern	Appendix I	Schedule I
Gharials 	Primary habitat in the river Chambal and the secondary habitat in the rivers of Ghagra, Gandak, Girwa (Uttar Pradesh), the Ramganga River (Uttarakhand), and the Son River (Bihar).	• Has long, thin snouts which resemble a pot. • Relatively harmless, fish-eating species. • Indicator species as their population reflects the health of the river system.	Critically Endangered	Appendix I	Schedule I

Indian Crocodile Conservation Project

In the 1970s the crocodile species faced severe population declines due to factors such as habitat loss, poaching, and pollution. To check this declining trend Indian Crocodile Conservation Project was launched in 1975 across various Indian states. It aimed to conserve the crocodile population in India

Gharial conservation:

The Gharial population has been experiencing a negative trend, and has been categorized as Critically endangered by IUCN. According to the studies, its population has declined from 5000-10000 to less than 250 since 1946. One of the major threats to the Gharial population is habitat loss and degradation due to human activities such as dam construction, river channelization, and sand mining. These activities result in the destruction of nesting sites and disrupt the natural flow of rivers, affecting the gharial's breeding and feeding habits. To check this negative trend, various steps have been taken, including

- The conservation of Gharial was first started in Odisha's Satkosia Gorge Sanctuary in 1975.
- In 1975, the Gharial Research and Conservation Unit (GRACU) at Tikarpada was formed as a joint conservation initiative by Odisha with technical support from UNDP and FAO.
- A gharial breeding center was built in Nandan Kanan Zoological Park (Odisha) to give a boost to the dwindling population.
- Under the ambitious program of the Punjab government, 24 Gharials were released to Beas Conservation Reserve with the help of WWF-India.
- In collaboration with the Uttar Pradesh Forest Department, WWF-India started a gharial reintroduction program at Hastinapur Wildlife Sanctuary.

DO YOU KNOW?

The World Crocodile Day is celebrated every year on the 17th of June. It was started by the Crocodile Research Coalition in collaboration with Belize Zoo.

Lesser Cats Project

After the launch of Project Tiger in 1973, the focus of policymakers shifted towards the lesser cats which faced threats such as habitat loss, human-animal conflict, poaching, etc. To protect the population of lesser cats, the project was launched in the year 1976 with the help of WWF.

- **Aim:** It was launched to conserve the four species of lesser cats found in West Bengal and the north-eastern states of India. The species included:
  - Leopard Cat (Felis bengalensis Kerr)
  - Marble Cat (Felis marmorta Martin,)
  - Felis Temmincki Vigors & Horsfield (Golden colored cat)
  - Fishing cat (Felis viverrina Bennet).

Recent Development

The Global Tiger Forum (GTF), launched a program entitled 'Strengthening conservation and resilience of globally significant wild cat landscapes' with a focus on small wild cat conservation in India.

Manipur Brow-Antlered Deer Project

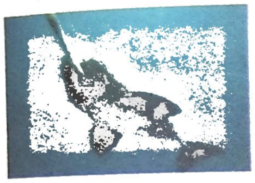
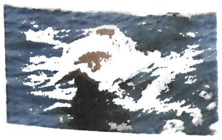
Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
Sangai/ Indian Eld Deer 	Found in Keibul Lamjao Park, Manipur.	• The Sangai Festival is named after this deer. • State animal of Manipur • -Known for its distinctive antlers. • Called as the dancing deer. • Threats: • Loss of habitat • Invasion of non-native plants • Poaching • Spreading of diseases from livestock animals.	Endangered	Appendix I	Schedule I

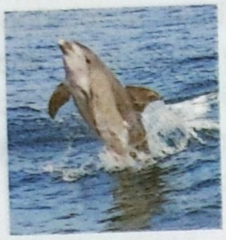
About Manipur Brow-Antlered Deer Project/ Project Manipur Thamin

Due to various factors such as habitat loss, encroachment, and hunting, the population of the Brow-Antlered Deer had drastically declined, pushing it to the brink of extinction in the 1960s and 70s. In response to this alarming situation, the Manipur Brow-Antlered Deer Project was launched in 1977.

- The project focuses on the conservation and management of the Sangai habitat, as well as the promotion of community participation in conservation efforts.
- It involves measures such as habitat restoration, anti-poaching activities, captive breeding and reintroduction programs, scientific research, and raising awareness among local communities about the importance of preserving this iconic species.

Conservation of Gangetic Dolphin

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
The Gangetic River Dolphin 	Found in the Ganges and tributaries of the river Brahmaputra. (In India and Bangladesh) -In India, they are found in the states of UP, MP, Rajasthan, Bihar, and Assam, Jharkhand and West Bengal.	• They only live in freshwater • Act as an indicator species, indicating the health of the river. • They are blind and hunt using ultrasonic sound. • It is also known as susu. • Susu refers to the noise made by the dolphin when it breathes. • Other freshwater dolphins in the world are a. **Baji** in the Yangtze River in China (Extinct) b. **Bhulan** in the Indus River in Pakistan. c. **Boto** in the Amazon River in South America.	Endangered	Appendix I	Schedule I
Indo-Ocean Humpback Dolphin 	Indian Ocean from South Africa to India.	Pinkish coloration, known for aerial displays	Endangered	Appendix I	Schedule I
Irrawaddy Dolphin	Coastal areas of South and Southeast Asia, as well as in three rivers: the namely- Ayeyarwady in Myanmar, the Mahakam in Indonesian Borneo, and the Mekong River.	Rounded head, unique vocalizations	Endangered	Appendix I	Schedule I

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
Indo-Pacific Bottlenose Dolphin 	Shallow coastal waters of the Indian Ocean, Southeast Asia, and Australia.	Highly intelligent, social creatures	Near Threatened	Appendix II	Schedule I
Finless Dolphins 	Saltwater niches along the coast of the Indo-Pacific Ocean.	Known for their distinct lack of a dorsal fin, which contributes to their exceptional maneuverability and agility in the water.	Critically Endangered	Appendix I	Schedule I
Striped Dolphin 	Offshore waters, Arabian Sea, Bay of Bengal	Long, slim body with distinct stripes	Least Concern	Appendix II	Schedule I

Conservation Initiatives for the Gangetic Dolphin

The population of Gangetic Dolphins has been declining due to various threats such as Habitat degradation, including pollution, sand mining, and river fragmentation. Moreover, the construction of dams and barrages disrupts their natural movement and affects their ability to find prey. In addition, illegal fishing practices and accidental entanglement in fishing nets result in dolphin mortality. To conserve their population, several initiatives have been taken, including:

- **Dolphin Sanctuary:** Vikramshila Ganges Dolphin Sanctuary was established in Bihar in 1991 under the Wildlife Protection Act, of 1972.
- **Conservation Action Plan for the Ganges River Dolphin 2010-2020:** It identified the major threats to Gangetic Dolphins and aimed to mitigate the issues.
- **National Aquatic Animal**: In 2009, the Gangetic River dolphin was declared as the national aquatic animal of India.
- **National Ganga River Dolphin Day**: Celebrated on 5th October.
- The first **National Dolphin Research Center** has been established on the premises of Patna University in Bihar.
- **Project Dolphin**: It is a proposed project under Arth Ganga, to be designed and implemented on the lines of Project Tiger. It will conserve both riverine and oceanic dolphin species.

Project Elephant

About Elephant

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
Asian Elephants 	Found in India. Majority of them are found in wet tropical evergreen forests.	Largest land mammals in Asia. Sociable animals.	Endangered	Appendix I	Schedule I

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
African Forest Elephant	Dense rainforests of Central and West Africa	Smaller in size compared to savanna elephants, with straighter tusks and rounded ears	Critically Endangered	Appendix I	
African Savannah Elephant	Savannas, grasslands, and woodlands	Largest land mammal, characterized by their long-curved tusks and large ears	Endangered	Appendix I ((Except the populations of Botswana, Namibia, South Africa and Zimbabwe, which are included in Appendix II)	

About Project Elephant

Due to factors such as habitat loss, fragmentation, poaching, and human-elephant conflicts there was a substantial reduction in the numbers of elephants during the 1980s. To reverse this declining trend and ensure the conservation and sustainable management of elephant populations and their habitats, it was launched in February 1992 as a centrally sponsored scheme.

- **Aim:** The project aims to provide financial and technical support to major elephant-bearing States in the country for the protection of elephants, their habitats, and corridors.
- **Objectives:**

The major objectives of the project Elephant are:

- To protect elephants, their habitat & corridors.
- To address issues of man-animal conflict.
- Welfare of captive elephants.
- Developing scientific and planned management
- Measures for the conservation of elephants.

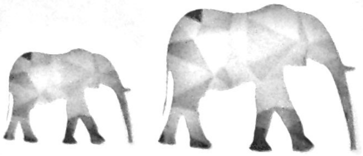
Elephant Reserves:

These are the designated areas established under Project Elephant to provide secure habitats and ensure the long-term survival of elephants. They are established under Project Elephant. They provide opportunities for elephants to thrive, reproduce, and maintain healthy population levels. They offer a range of protected habitats, including forests, grasslands, wetlands, and riverine ecosystems, which are essential for the elephants' survival. As of May 2023, there are a total of 33 Elephant Reserves in India.

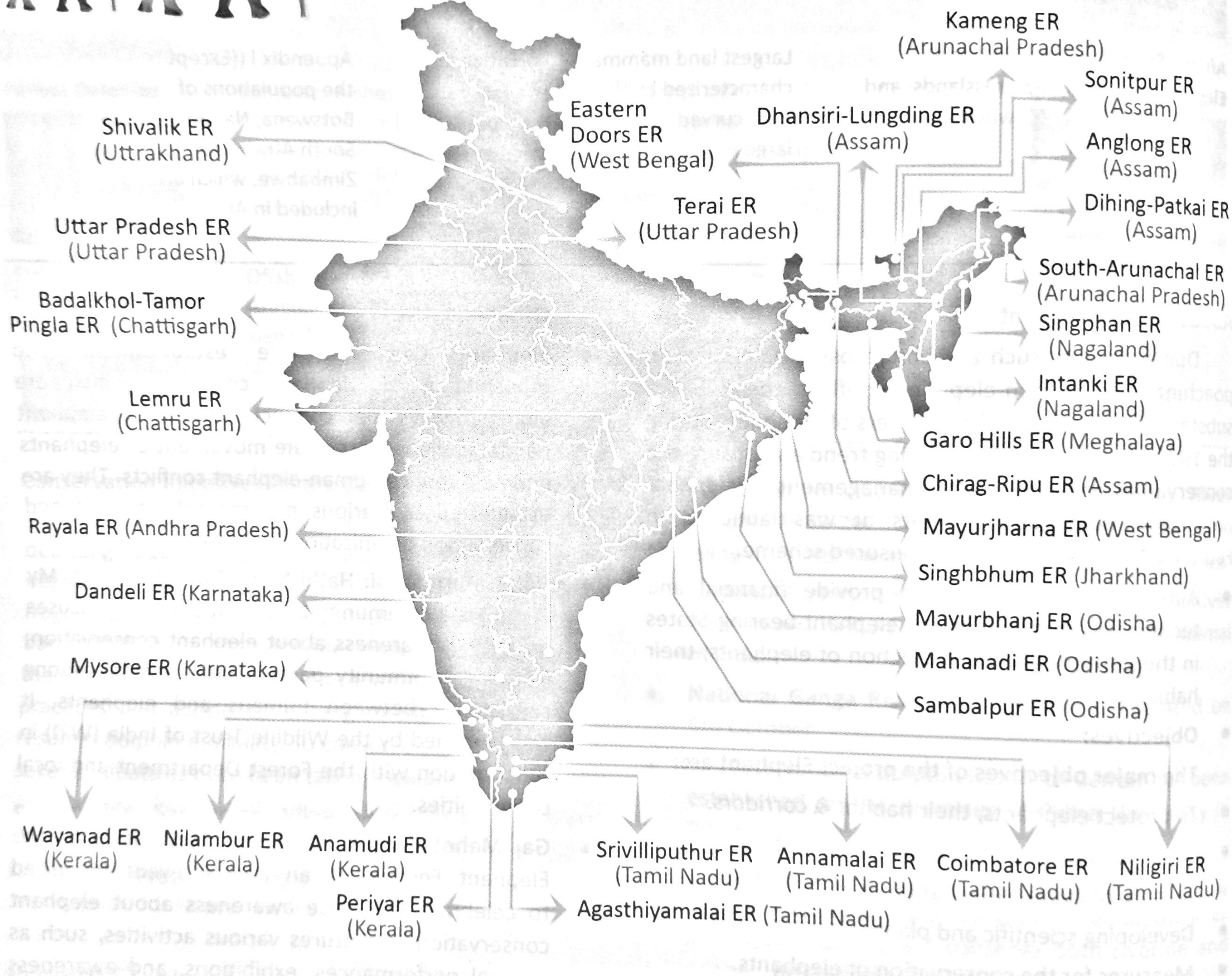
Other Initiatives

- **Elephant Corridors:** The establishment and preservation of elephant corridors, which are vital pathways that connect fragmented elephant habitats, allow for the safe movement of elephants and help reduce human-elephant conflicts. They are established by various government agencies and conservation organizations in India.
- **Hathi Mere Sathi:** Hathi Mere Sathi (Elephant, My Friend) is a community-based initiative that focuses on raising awareness about elephant conservation, fostering community participation, and promoting coexistence between humans and elephants. It was launched by the Wildlife Trust of India (WTI) in collaboration with the Forest Department and local communities.
- **Gaj Mahotsav:** Gaj Mahotsav, also known as the Elephant Festival, is an annual event organized to celebrate and raise awareness about elephant conservation. It features various activities, such as cultural performances, exhibitions, and awareness campaigns. It is organized annually by the Ministry of Environment, Forest and Climate Change, involving various stakeholders, including government agencies, NGOs, and local communities.
- **Project RE-HAB:** It is launched by the Khadi and Village Industries Commission (KVIC), and is a unique initiative aimed at reducing and eliminating human-elephant conflicts in India. It involves the creation of "Bee fences", in which Bee boxes are strategically placed along the pathways frequently used by elephants, acting as a natural deterrent and preventing their entry into human territories.

- **Monitoring the Illegal Killing of Elephants (MIKE):** The CITES **Monitoring the Illegal Killing of Elephants** (MIKE) Programme is a site-based system designed to monitor trends in the illegal killing of elephants, build management capacity and provide information to help range States make appropriate management and enforcement decisions.



Latest elephant reserve (33rd) - Terai Elephant Reserve (Uttar Pradesh)



Elephant Reserves in India

Mike Site	Location
Chirang Ripu	Assam
Dhang Patki	
Eastern Dooars	West Bengal
Deomali	Arunachal Pradesh
Garo Hills	Meghalaya

Mike Site	Location
Mayurbhanj	Orissa
Mysore	Karnataka
Nilgiri	Tamil Nadu
Shivalik	Uttarakhand
Wayanad	Kerala

Project Red Panda

About Red Panda

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
Red Pandas 	India, Nepal, Bhutan, and the northern mountains of Myanmar and southern China. In India, found in Sikkim, Arunachal Pradesh, West Bengal, and Meghalaya.	-Shy, solitary and arboreal in nature. -An indicator for ecological change. -Feeds mainly on bamboo. -Use their tails for balancing and covering themselves in winter.	Endangered	Appendix I	Schedule I

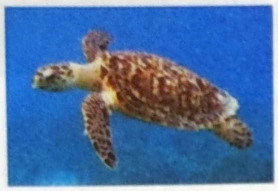
Project Red Panda:

- **Background**: Red pandas have experienced significant population declines primarily due to habitat loss and fragmentation. The destruction of their bamboo forest habitats, often caused by deforestation for agriculture, timber extraction, and human settlements, has led to a decline in suitable living areas for red pandas. This habitat loss has resulted in fragmented populations, making them more vulnerable to extinction. To improve their natural habitat and check the declining population, Project Red Panda was started in 1994 with the help of the World Wildlife Fund (WWF).
- **Aim**: To protect the vulnerable natural habitat of Red Pandas, to train field workers, and to increase the cooperation between different Red Panda ranging states.

Turtle Conservation

Turtles in India

Species	Habitat	Characteristics	Conservation Status		
			IUCN	CITES	WPA
Leith's Soft-Shell Turtle 	-Endemic to Peninsular India. -Found in the rivers like Cauvery, Tungabhadra, Ghataprabha, Bhavani, Godavari, and Moyar.	-Large freshwater turtle. -Can grow up to 1 m in size. -Threats: * Used in traditional Chinese medicine * For soup delicacy	Critically Endangered	Appendix I	Schedule IV
Red Crowned Roofed Turtle 	-Native to India, Nepal, and Bangladesh. -Substantially found in the National Chambal River Ghariak Sanctuary.	-Live in freshwater. -Found in deep-flowing rivers. -Males are shorter in comparison to the female turtles. -Threats: * Loss of Habitat *Drowning by illegal fishing net *Poaching *Illegal trade	Critically Endangered	Appendix II	Schedule I

Species	Habitat	Characteristics	Conservation Status		
			IUCN	CITES	WPA
Hawksbill Turtle 	-Throughout the world's tropical oceans, predominantly in coral reefs	-Hawksbills are named for their narrow, pointed beak. -Have a distinctive pattern of -Overlapping scales patterned shells make them highly valuable -Feed mainly on sponges	Critically Endangered	Appendix I	Schedule I
Bengal Roof Turtle 	-Native to India, Bangladesh, and Nepal	-Characterized by the bright colors such as red, yellow, white and blue on the faces and necks of the males -The males are shorter and reach only half their length	Critically Endangered	Appendix I	Schedule I
Olive Ridley Turtle 	Tropical and subtropical waters of Pacific, Indian, and Atlantic Oceans	Heart-shaped carapace, medium-sized sea turtle, known for arribada nesting behavior and synchronized mass nesting	Vulnerable	Appendix I	Schedule I

Conservation Measures

- **The Government of India – UNDP Sea Turtle Project:** Launched in 1999, it is a national sea turtle conservation project which is being executed by MoEFCC with the Wildlife Institute of India. It has the following components:
    - extensive surveys along the coast,
    - reviews of legislation and community-based conservation,
    - education and awareness,
    - GIS studies of key nesting areas,
    - training for wildlife and fisheries managers and field biologists.
- **Operation Turtshield:** It was launched by Wildlife Crime Control Bureau, India to curtail poaching and illegal trade of freshwater turtles. The operation focuses on reducing accidental bycatch, protecting nesting sites, and raising awareness among local communities. It involves the deployment of trained personnel, surveillance measures, and community engagement to ensure the survival of these endangered turtles and their habitats.

Project Rhino

Different Species of Rhino

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
Great One-Horned Rhino/Indian rhino 	Indo- Nepal terai and Northern West Bengal, and Assam	They have a single horn, which is present in both the sexes and they are largest of all the Asian rhinos.	Vulnerable	Appendix I	Schedule I

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
Javan Rhinoceros 	Java, Indonesia	One of the rarest and most endangered large mammals	Critically Endangered	Appendix I	
Sumatran Rhinoceros 	Sumatra, Indonesia	Smallest rhino species, highly threatened due to habitat loss and poaching	Critically Endangered	Appendix I	
Black Rhinoceros 	Eastern and southern Africa	Notable for its two horns, critically endangered due to poaching and habitat loss	Critically Endangered	Appendix I	
White Rhinoceros 	Southern Africa	Largest rhino species, characterized by its square-shaped mouth, classified into southern and northern	Near Threatened	Appendix II	

Indian Rhino Vision 2020

Due to threats such as trophy hunting, poaching for the horns, and habitat destruction, at one point of time, the Rhinos were on the verge of extinction. To combat this situation and protect their population and habitat, Project Rhino was launched in 2005. The main objectives were:

- To increase the population of the Indian Rhinos to 3000 from 2000 by the year 2020 in seven protected areas of Assam.
- To distribute the population of Rhino across Seven protected areas which are Kaziranga NP, Pobitora NP, Orang National Park, Manas National Park, Laokhowa wildlife sanctuary, Burachapori wildlife sanctuary, and Dibru Saikhowa wildlife sanctuary.

Achievements of IRV 2020

- The first objective to increase the population to 3000 has been achieved and the numbers are well passed the 3000 mark as declared by MoEFCC in 2021.
- The second objective to distribute the population around seven protected areas has not been achieved.

Other initiatives:

- **'The New Delhi Declaration on Asian Rhinos 2019':** It was signed by five rhino range nations (India, Bhutan, Nepal, Indonesia, and Malaysia) for the conservation and protection of the species. The declaration emphasized the commitment to conserve and protect rhinoceros' populations. It highlighted the importance of collaboration, information sharing, and joint efforts to address common challenges faced by Asian rhinos.
- **National Rhino Conservation Strategy**: It was launched in 2019, by the Government of India to guide rhino conservation efforts across the country. It includes measures such as habitat restoration, anti-poaching operations, community involvement, research, monitoring, and capacity building.

Vulture Conservation

Vulture Species in India

There are 9 Vulture species found in India, namely

Species	Habitat	Important Facts	Conservation Status			
			IUCN	CITES	WPA	CMS
Oriental White-backed Vulture	Open grasslands, scrublands, and forested areas, found in various states including Uttar Pradesh, Bihar, West Bengal, Assam, and others	Recognized by its pale creamy-white plumage and contrasting black flight feathers	Critically Endangered	Appendix II	Schedule I	Appendix I
Long-billed Vulture	Open grasslands, savannas, and forested regions, found in various states including Rajasthan, Madhya Pradesh, and others	Distinguished by its long and slender bill, ideal for tearing flesh and accessing the bone marrow	Critically Endangered	Appendix II	Schedule I	Appendix I
Slender-billed Vulture	Open habitats, including grasslands, forests, and wetlands, found in various states including Uttar Pradesh, Assam, and others	Known for its slim and narrow beak, enabling it to extract meat from carcasses more efficiently	Critically Endangered	Appendix II	Schedule I	Appendix I
Himalayan Vulture	Mountainous regions, including the Himalayas, found in states like Himachal Pradesh, Uttarakhand, and Arunachal Pradesh	Identified by its large size, broad wings, and distinctive black and white plumage	Near Threatened	Not listed	Schedule-IV	Appendix II
Eurasian Griffon	Various habitats, including open areas and mountains, found in states like Jammu and Kashmir, Himachal Pradesh, and others	Characterized by its pale plumage, large size, and prominent white feathers on the neck and head	Least Concerned	Not listed	Schedule-IV	Appendix II
Red-headed Vulture	Grasslands, forests, and open areas, found in various states including Uttar Pradesh, Bihar, and others	Recognizable by its bright red head and neck, contrasting with its black body plumage	Critically Endangered	Appendix II	Schedule-IV	Appendix I
Egyptian Vulture	Various habitats, including open areas and deserts, found in states like Rajasthan, Gujarat, and others	Noted for its small size, distinctive yellow face, and slender curved bill	Endangered	Appendix II	Schedule IV	Appendix I

Species	Habitat	Important Facts	Conservation Status			
			IUCN	CITES	WPA	CMS
Bearded Vulture	Mountainous regions, including the Himalayas, found in states like Jammu and Kashmir, Himachal Pradesh, and others	Uniquely adorned with a tuft of bristly feathers on its chin, giving it the appearance of having a beard	Near Threatened	Appendix II	Schedule I	Appendix II
Cinereous Vulture	Open grasslands and forested regions, found in various states including Rajasthan and Gujarat.	One of the largest vultures, recognized by its dark plumage, heavy build, and strong hooked bill	Near Threatened	Appendix II	Schedule IV	Appendix II

Project Vulture

Between the 1990s and mid-2000s, India witnessed a significant decline in its vulture population, with a staggering loss of around 95%. This decline was attributed to various factors, including trophy hunting, habitat loss, electrocution from power lines, mobile towers, and the widespread use of the veterinary drug **Diclofenac**, which was highly toxic to vultures. In response to this alarming situation, the Indian Government launched Project Vulture in 2006. The major objectives of the Project Vulture are:

- Analyze and limit the factors that cause the declining trend of the Vulture population.
- Maintain a viable population of Vultures
- Protect the natural habitat of the vultures.
- Establish Vulture Safety Zones.

Other Initiatives:

- **Vulture Safety Zones:** These are the special area that is demarcated around a 150 KM radius of the Vultures colonies to create awareness and to ensure that Diclofenac and other toxic veterinary drugs are not being used. Thy are being established in several states of India, especially in Gujarat.
- **Vulture Conservation Breeding Programme**: It was launched by the Central Zoo Authority (CZA) and Bombay Natural History Society (BNHS). Jataayu Conservation Breeding Centre within Bir Shikargah Wildlife Sanctuary, Pinjore has been established.
- **Vulture Restaurants:** It is a site where decaying flesh from dead animals, is deposited in order to provide safe food to vultures. The first "vulture restaurant" was opened in 2015 at the Phansad Wildlife Sanctuary.
- **Vulture Action Plan 2020-25:** It was developed by the Government of India to conserve and restore vulture populations in the country. The major objectives of the Action Plan are:
  - Prevention of poisoning of cattle carcasses, the principal food of vultures
  - Enhancement of the Conservation Breeding Programme in the country
  - Regular monitoring of vultures across the country
  - Enhancing the vulture safe zone network by creating at least one vulture safe zone in each state and continuing to work on the existing efforts of vulture safe zone.
  - Determining and preventing other causes of mortality in vultures

SAVE (Saving Asia's Vultures from Extinction)

It is a consortium of regional and international organizations including the Bombay Natural History Society (BNHS), the Royal Society for the Protection of Birds (RSPB) etc. It aims to oversee and coordinate conservation, campaigning, and fundraising activities to help conserve South Asia's vultures.

Project Snow Leopard

About Snow Leopard

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
Snow Leopard	-Found in Afghanistan, Bhutan, India, Snowy hilly Parts of Central Asia, Republic, Mongolia, Nepal, Pakistan, Russia. -In India, it is found in the western Himalayas, Union Territories of J&K and Ladakh, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh in the eastern Himalayas. -The largest population is found in China.	-Called Ghost Mountain due to its camouflage. -Black spot pattern called as rosettes is unique to every snow leopard.	Vulnerable	Appendix I	Schedule I

Project Snow Leopard

Due to continuous unsustainable development in mountains, habitat loss, poaching, Human-Animal conflicts, etc., their population was under immense pressure. To address the threats and conserve the snow leopard population, the project was launched in 2009 by the Govt. of India. The major objectives of the project are:

- To protect and maintain the population of Snow Leopard.
- Invest in Research and Development to achieve scientific goals.
- Preserve the unique and vulnerable natural habitat of Snow Leopard.
- **Conservation Strategy:** Following activities are undertaken project:

1. This project is operational in **Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh** by the Mysore-based Nature Conservation Foundation and the active support of the Wildlife Institute of India.
2. Under this, the landscape approach is followed under which a smaller core zone with high conservative potential is identified.
3. Community involvement is the key to the project which provides local knowledge and expertise.
4. Financial and technical support is provided by the Central Government.

Other Initiatives

- **Global Snow Leopard and Ecosystem Protection (GSLEP) Programme:** It is the alliance of 12 snow leopard range countries and was established in 2013 by the **Bishkek Declaration**. It aimed to secure at least 20 snow leopard landscapes by 2020 or, in short – "Secure 20 by 2020."

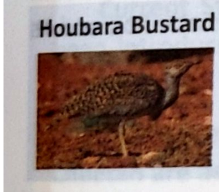
12 Snow Leopard Countries:

Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyz Republic, Mongolia, Nepal, Pakistan, Russian Federation, Tajikistan, and Uzbekistan.

- **SECURE Himalaya:** It is being implemented by MoEFCC in collaboration with UNDP. It aims to promote sustainable management of alpine pastures and forests in the high-range Himalayan ecosystems to secure the conservation of globally significant wildlife, including endangered snow leopard and their habitats. There are four components of the Project:
    - Conservation of key biodiversity areas
    - Securing sustainable community livelihoods
    - Enhancing enforcement, monitoring, and cooperation to reduce wildlife crime and related threats
    - Gender Mainstreaming, Monitoring, evaluation, and knowledge management

Project Great Indian Bustard

Bustards in India

Species	Habitat	Important Facts	Conservation Status		
			IUCN	CITES	WPA
The Great Indian Bustard	Grasslands and semi-arid regions in Rajasthan, Gujarat, and Maharashtra	One of the heaviest flying birds	Critically Endangered	Appendix I	Schedule I
Lesser Florican	Grasslands and agricultural fields in Rajasthan, Madhya Pradesh, Maharashtra, and Karnataka	Smallest bustard species in India, known for its elaborate courtship displays	Critically Endangered	Appendix I	Schedule I
Bengal Florican	Wet grasslands and marshy areas in Assam and West Bengal	highly dependent on tall grasslands, faces threats from habitat loss and fragmentation	Endangered	Appendix I	Schedule I
Houbara Bustard 	Migratory, found in the western region of India	Migratory species, vulnerable to habitat loss and hunting during its wintering grounds in India	Vulnerable	Appendix II	Schedule IV
MacQueen's Bustard	Semi-arid and arid regions, mainly found in Rajasthan	Rare species, localized to the Thar Desert region	Endangered	Appendix I	Schedule I
Jerdon's Courser	Scrublands and forests in Andhra Pradesh and Telangana	nocturnal and secretive bird	Critically Endangered	Appendix I	Schedule I

Project Great Indian Bustard

The Great Indian Bustard were on the verge of extinction due to several issues such as electrocution with power transmission lines, trophy hunting (still prevalent in Pakistan), habitat loss and agricultural expansion, etc. To combat the adverse threats and protect their small population, the project was launched in 2013 by the State Government of Rajasthan.

- **Aim:** To construct breeding enclosures in the state to protect the limited population and reduce human disturbance and pressure in their habitat.
- **Current Situation:** According to IUCN, there are less than 250 individuals of Great Indian Bustard in India as of 2021.

Project Lion

Species	Habitat	Characteristics	Conservation Status		
			IUCN	CITES	WPA
African Lion	Sub-Saharan Africa	Largest African carnivore, social behavior, males with prominent manes	Vulnerable	Appendix II	
Asiatic Lion	Gir Forest National Park, Gujarat, India	Smaller than African lions, males have less pronounced manes, adapted to dry deciduous forest habitat in India	Endangered	Appendix I	Schedule I

About Project Lion

There are only 600 individuals Asiatic Lions left in India. The lions face continuous threats due to habitat loss, poaching, and human-wildlife conflicts, etc. To check these threats and conserve the limited population of Asiatic Lion, Project Lion was launched in 2019 by the Ministry of Environment, Forest, and Climate Change. The main objectives of the Project are as follows:

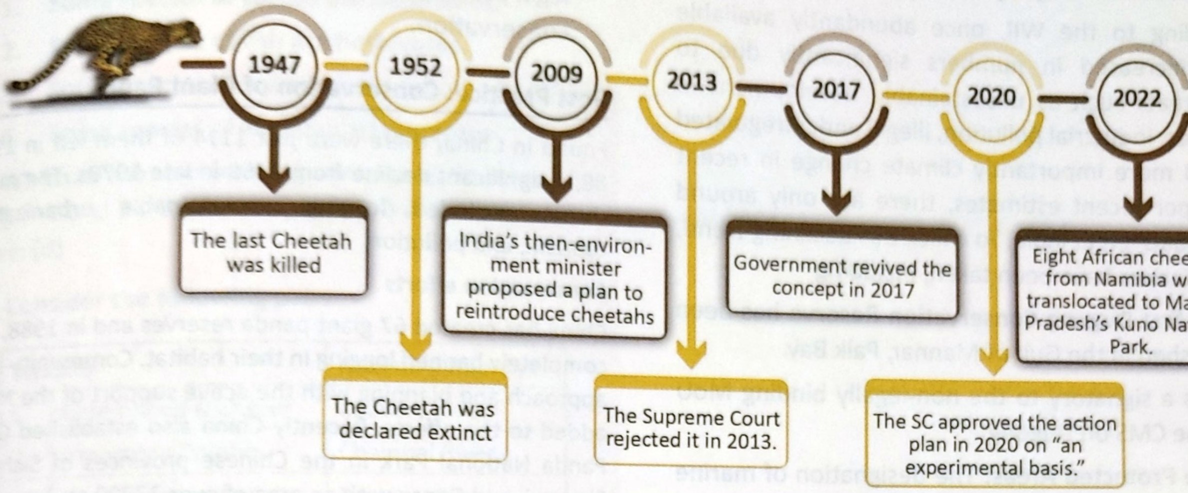
- Conservation and protection of the critically endangered Asiatic lion population.
- Safeguarding the lion's habitat from encroachment, fragmentation, and degradation.
- Mitigating human-lion conflicts to ensure the safety of both communities and the lions.
- Strengthening anti-poaching measures to combat illegal hunting and trade of lion parts.
- Implementing scientific monitoring and research to gather crucial data on lion behavior, population dynamics, and habitat requirements.
- Enhancing the capacity of local communities and stakeholders in lion conservation efforts.
- Establishing additional habitats and populations of Asiatic lions to reduce the risk of a single catastrophic event affecting the entire population.
- Promoting public awareness and education about the importance of conserving the Asiatic lion and its ecosystem.

Reintroduction of Cheetahs in India

About Asiatic and African Cheetah

Species	Habitat	Important Facts	Conservation Status	
			IUCN	CITES
Asiatic Cheetah	Found only in Iran with less than 100 individuals left.	• Smaller than the African Cheetahs. • Have pale yellowish fawn-colored skin with more fur under their body, specifically on the belly. • Have much less prominent spots and lines on their face.	Critically endangered	Appendix-I
African Cheetah	Found all over the African continent in thousands of numbers.	• Larger than the Asiatic counterpart. • Have slightly brownish and golden skin which is thicker than the Asiatic Cheetahs. • Have much more prominent spots and lines on their face as compared to their Asian cousins. • World's Fastest Mammal. • Unlike other big cats, they don't roar.	Vulnerable	Appendix-I

Project Cheetah



1947: The last Cheetah was killed

1952: The Cheetah was declared extinct

2009: India's then-environment minister proposed a plan to reintroduce cheetahs

2013: The Supreme Court rejected it in 2013.

2017: Government revived the concept in 2017

2020: The SC approved the action plan in 2020 on "an experimental basis."

2022: Eight African cheetahs from Namibia were translocated to Madhya Pradesh's Kuno National Park.

It is the world's first inter-continental large wild carnivore translocation project and was formally launched in September 2022. It aims to restore the population of Cheetah in India, which was declared extinct in 1952. It has an ambitious target to introduce at least 50 cheetahs in different national parks of India in the next 5 years. It falls under **Project Tiger** and is implemented by **the National Tiger Conservation Authority (NTCA).**

Current Status: As of May 2023, 20 cheetahs have been introduced into the **Kuno National Park** (Madhya Pradesh) from Namibia and South Africa.

Concerns: The major concerns associated with Project Cheetah are as follows:

- **Genetic Adaptation:** Cheetahs that will be translocated to India may have adapted to different environmental conditions and ecosystems in their native range. Ensuring their successful adaptation to the new habitat in India and their ability to thrive in different climatic and ecological conditions is a significant concern.
- **Prey Availability:** Cheetahs have specific dietary requirements, mainly relying on a few select prey species. Ensuring an adequate and sustainable prey base for the translocated cheetahs in their new habitat is crucial for their survival and successful establishment.
- **Human-Wildlife Conflict:** Introducing a large predator like the cheetah into new areas can potentially lead to conflicts with local communities, especially if the cheetahs come into contact with livestock or if their presence poses any threat to human safety. Mitigating human-wildlife conflicts and promoting coexistence is an important consideration.
- **Habitat Suitability:** Assessing the suitability of the habitat in the receiving areas is critical. Adequate evaluation of the existing ecological conditions, availability of suitable habitats, prey availability, and connectivity with other protected areas must be done to ensure the successful establishment of the translocated cheetahs.
- **Disease Transmission:** Disease transmission between translocated cheetahs and other wildlife, including domestic animals, is a significant concern.

Dugong Conservation

About Dugongs

Species	Habitat	Characteristics	Conservation Status		
			IUCN	CITES	WPA
Dugong	Mainly in shallow coastal waters of the Indian and western Pacific Oceans.	known as "sea cows", they have streamlined bodies and unique snouts. They can reach lengths of up to 3 meters and weigh around 400 to 600 kilograms. They are characterized by a rounded tail fin, paddle-like flippers, and a muzzle with bristly whiskers	Vulnerable	Appendix I	Schedule I

Initiatives taken for Dugong Protection:

According to the WII, once abundantly available Dugongs decreased in numbers significantly due to various threats such as unsustainable development in coastal areas, industrial pollution, illegal and unregulated fishing and more importantly climate change in recent times. As per recent estimates, there are only around 250 individuals left in India. To check this declining trend, several initiatives have been taken, including

1. India's first **Dugong Conservation Reserve** has been established in the Gulf of Mannar, Palk Bay.
2. India is a signatory to the non-legally binding MoU with the CMS on Dugong.
3. **Marine Protected Areas:** The designation of marine protected areas, such as the Gulf of Mannar Marine National Park, the Gulf of Kutch Marine National Park, and the Andaman and Nicobar Islands, provides legal protection to dugong habitats and helps in their conservation.

Best Practice: Conservation of Giant Panda

Found in China, there were just 1114 of them left in 1985-88, a significant decline from 2459 in late 1970s. The major threats included logging, unsustainable urbanization, tourism, and pollution.

Conservation efforts

China has created 67 giant panda reserves and in 1988, and completely banned logging in their habitat. Community-level approach and planning with the active support of the NGOs added to the efforts. Recently China also established Giant Panda National Park in the Chinese provinces of Sichuan, Shaanxi, and Gansu with an area of over 27000 sq. km.

As a result of the efforts, there has been considerable increase in Giant Panda population. Moreover, now their status has changed from Endangered to Vulnerable.

Previous Year questions

CHAPTER

10

CONSERVATION OF MANGROVES

MANGROVES

Mangroves are a group of trees and shrubs that live in the coastal intertidal zones. They are well adapted to lose and wet soils, salt water and being periodically submerged by tides.

Characteristics of Mangrove Vegetation

- **Unique location:** They are mainly found along the coastal areas and grow on sheltered shores, deltas, estuaries, bays, creeks, and barrier islands. Moreover, they grow in inter-tidal coastlines, meaning every 24 hours, they are inundated by seawater.
- **Salt Tolerance:** Mangrove vegetation have specialized mechanism for survival in high salinity environment. They possess salt-filtering root systems. Further, they can also excrete salt through glands located on their leaves.
- **Root system:** Mangroves have prop roots (aerial roots) or pneumatophores (blind roots). These roots help anchor the plants in the muddy substrate and also help them to obtain oxygen even in waterlogged conditions.
- **Reproduction**: The mangrove trees use a Viviparity mode of reproduction in which seeds germinate in the tree itself to overcome the limitation of reproduction in saline water.

Distribution of Mangroves

Global

Mangrove Forests cannot tolerate freezing temperatures; hence they are mostly found in the tropical and subtropical regions of the earth along the coastal areas. There are more than 80 species of mangroves found in the world that covers an area of approximately 1,47000 sq. km. Of this Asia has the largest area of Mangroves worldwide, followed by Africa, and North and Central America

Country-wise, Indonesia has the highest area of mangrove coverage (19%), followed by Australia (10%) and Brazil and Nigeria (each with 7%).

India

According to the Forest Survey of India, the total area under Mangrove Forest is 4,975 sq km, which is 0.15% of the country's total geographical area. State-wise, West Bengal (42.45%) has the highest Mangrove Forest area followed by Gujarat (23.66%) and Andaman & Nicobar Islands (12.39%).

Important Mangrove Forests in India

Mangrove Forest	Location
Sundarbans Mangroves	Ganga-Brahmaputra Delta in West Bengal
Bhitarkanika Mangroves	Odisha; formed in the deltaic region of River Brahmani and Baitarani
Godavari-Krishna Mangroves	Eastern coast of India and extend from Odisha to Tamil Nadu. these are formed at the deltas of several eastern flowing rivers such as Mahanadi, Godavari, Krishna, Cauvery, etc.
Backwaters of Kerala	Kerala
Pichavaram Mangroves	Tamil Nadu

Mangroves in India

Significance of the Mangroves

- **Coastal Protection**: Mangroves act as a natural barrier against storm surges, hurricanes, and sea-level rise, protecting coastal communities. For example, a study released in 2005 in in the journal Science, reported that coastal communities in Sri Lanka with intact mangrove forests suffered less damage than those without mangroves during the 2004 Indian Ocean Tsunami.
- **Carbon Sequestration:** NASA referred to mangroves as the «best carbon scrubbers» due to their ability to sequester and store large amounts of carbon dioxide from the atmosphere in their biomass and soil. **According to a UN study,** mangroves can store up to four times more carbon per unit area than tropical rainforests.
- **Rich in Biodiversity:** Mangroves support a wide variety of species due to the edge effect. For example, the Sundarbans supports around 30 plant species of mangroves & houses over 250 species of birds, 120 species of fishes, reptiles like salt water crocodiles.
- **Water Purification:** When water from rivers and floodplains flow into ocean, mangroves filter a lot of sediments, hence protecting the coastal ecology including coral reefs. Mangroves also act as phytoremediers- they have the ability to filter out heavy metals from the mud and store them in their sediments. For example, In Ecuador, a contaminated estuary was restored by planting 22,000 mangroves in the region of estuary using its phytoremediation capabilities.
- **Soil Protection:** The roots of Mangrove forests bind the soil particle and help to protect the top and fertile layer of the soil.

- **Food Security:** Mangroves provide habitat for numerous fish and shellfish species, which are a critical source of protein for many coastal communities. For example, according to a study published in the journal "Fisheries Management and Ecology," mangroves in Indonesia support over 100 fish species, many of which are important for local food security.

Threats to Mangroves

- **Deforestation:** Mangrove forests are often cleared for agricultural, industrial, and urban development, resulting in the loss and degradation of these valuable ecosystems. For example, the Sundarbans mangrove forest has been deforested to create shrimp farms, rice paddies, etc.
- **Extensive Shrimp farming:** The expansion of shrimp aquaculture has resulted in the conversion of extensive mangrove areas into artificial ponds for shrimp farming. For example, large-scale shrimp farming industry in the Indian state of Andhra Pradesh has led to the destruction of mangrove forests along the coast.
- **Coastal Development:** Development activities such as tourism, ports, and urbanization lead to destruction and degradation of mangrove forests. According to UNESCO's World Heritage Centre, world has already lost around 50% of its original mangrove cover, and the rate of loss is accelerating at a rate much faster than other types of forests due to infrastructure development, and urbanization.
- **Construction of Dams:** The construction of dams along river courses has adverse effects on mangrove forests, leading to reduced freshwater and sediment inputs and changes in salinity levels. Moreover, dams obstruct the migration of fish and other aquatic species, causing disruptions in the food chain and biodiversity within the ecosystem. For example, the building of multiple dams along the Mekong River course has severely impacted the mangroves in the Mekong Delta region by altering the flow of the river and sediment dynamics.
- **Climate Change and Sea Level Rise:** Rising sea levels and increasing temperatures can impact the health and growth of mangrove trees, making them more vulnerable to disease and pests. According to research conducted by the School of Oceanographic Studies at Jadavpur University, rise in sea level has resulted in the loss of approximately 125 sq. km of mangrove forest cover in the Sundarbans region between 1986 and 2012.
- **Pollution:** Industrial and agricultural pollution lead to loss of mangrove forests by damaging their water quality and reducing the amount of sunlight that reaches the forest floor. For example, the Sundarbans are threatened by the discharge of untreated industrial effluents and agricultural run-off into the rivers located in the region.

How destruction of coral reefs impact mangroves?

The destruction of coral reefs is a factor contributing to the decline of mangrove forests. This is because coral reefs serve as the primary line of defense against powerful waves. When coral reefs are destroyed, the coastal areas become more susceptible to unusually strong waves. This results in washing away of the fine sediment that provides the foundation for the growth of mangroves. As a result, seedlings struggle to establish roots, and the nutrients needed for mangrove ecosystems to survive are stripped away.

Global Initiatives for Mangrove protection

- **Mangroves for the Future Initiative:** It is a multi-country initiative developed by the IUCN and UNDP. It aims to protect the mangroves in a coordinated way using technologies. Members of this initiative include Bangladesh, Cambodia, India, Indonesia, Maldives, Myanmar, Pakistan, Seychelles, Sri Lanka, Thailand, and Vietnam.
- **Mangrove Alliance for Climate (MAC):** It was launched in 2022 at COP27 of the UNFCC by the UAE in partnership with Indonesia. It aims to scale up and accelerate the conservation and restoration of the mangrove forests. The members of the alliance include India, UAE, Indonesia, Australia, Japan, Spain and Sri Lanka.
- **International Society for Mangrove Ecosystems (ISME):** It is a non-governmental organization established in 1990. It aims to promote the study of mangroves with the purpose of enhancing their conservation, rational management, and sustainable utilization.
- **International Day for the Conservation of the Mangrove Ecosystem:** UNESCO celebrates July 26 as the International Day for the Conservation of the Mangrove Ecosystem. It aims to raise awareness about mangrove ecosystems and to promote their conservation.

Indian Initiatives for Mangrove protection

- **National Mangrove Committee**: Formed in 1976, the National Mangrove Committee under the MoEFCC, is responsible for advising the Central Government the planning and implementation of policies for mangrove protection.
- **Conservation and Management of Mangroves and Coral Reefs:** Under this programme, annual Management Action Plan (MAP) for conservation and management of mangroves are formulated and implemented in all the coastal States and Union Territories.
- **UNESCO and Ramsar Sites**: Various Mangroves sites are designated under the UNESCO World Heritage Sites and Ramsar Sites for all-around protection and cooperation. For example, Sundarbans Mangrove Site under the UNESCO World Heritage site and Bhitarkanika Mangrove site under the Ramsar Site.
- **MISHTI:** In Budget 2023, a new mission called Mangrove Initiative for Shoreline Habitats and Tangible Income (MISHTI) was launched. It aims at mangrove preservation and conservation. It will facilitate mangrove plantation along India's coastline and on salt pan lands. It will be implemented through the convergence of the job guarantee scheme MGNREGS, the Compensatory Afforestation Fund, and other funding sources.

State Specific Initiatives

- **Andhra Pradesh** has formed dedicated and focused bodies to plan and implement the conservation projects for the Mangrove forests. It has also promoted community participated mangrove management
- **Maharashtra** is implementing restoration, protection, regeneration, and maintenance techniques with the help of new-age technologies such as satellites, Drones, and AI.
- **Gujarat** is using direct seed sowing raised bed plantations, and fishbone channel plantations to restore degraded mangroves.
- **West Bengal**: A mangrove resource center has been established in the Sundarbans Mangrove site for intelligent planning and implementation.

Fishbone channel plantation is used to artificially inundate areas that do not get regular tidal inundation. By flooding dried-up wetlands near the intertidal zones, new mangroves can be reforested.

11

CONSERVATION OF CORAL REEFS

CORAL BLEACHING

Coral reefs, the 'rainforests of the sea', are some of the most biodiverse and productive ecosystems on earth. As per United Nation Environmental Programme (UNEP), They **occupy less than one percent of the ocean floor, yet are home to 25 percent of marine species.** Crustaceans, reptiles, seaweeds, bacteria, fungi, and over 4000 species of fish make their home in coral reefs. They are net **sinks for carbon** and also **contribute to fixing nitrogen.**

Corals and Coral Reefs

Corals are **tiny, jelly-like animals** that live in colonies in warm, clear, shallow waters close to the coast. Corals **live symbiotically with photosynthetic algae**, providing them shelter in return for food. Corals are abundant near submerged banks where nutrients are supplied by upwelling currents.

Coral Reefs: They build hard external skeletons from carbonates dissolved in seawater. These hard **calcium-rich shells accumulate to form rock-like structures called coral reefs.** In open oceans corals create circular or horse-shoe shaped islands known as atolls.

Ideal Conditions for the Development of Coral Reefs

- **Warm Temperature**: Coral reefs cannot tolerate water temperatures below 18° Celsius. Many grow optimally in the water temperature range of 23°–29° Celsius, but some can tolerate temperatures as high as 40° Celsius for short periods.
- **Salinity:** Freshwater is not suitable for coral growth and muddy water clogs their pores, thus, causing death. They require moderate to low levels of salinity of around 30-40 parts per 1000 and ocean water free from sediments.
- **Depth and Clarity of Water:** Coral polyps require a suitable platform within the favorable depth for its growth. The water must also be clear and shallow so that a maximum amount of light penetrates it.
- **Moving Water**: Moving water ensures the supply of oxygen and the avail-ability of planktons in abundance. Corals do not grow in areas that are frequently visited by violent storms.
- **Type of Surface**: For solidification of the Coral polyps, a semi-hard or hard surface is required.

Types of Coral Reefs

There are three types of coral reefs viz. fringing reefs, barrier reefs and atolls.

- **Fringing Reefs**: Reefs that grow near the coastline around islands and continents are called fringing reefs. They are separated from the shore by a shallow lagoon known as 'Boat channels. Example: Ningaloo Reef along the western coast of Australia.
- **Barrier Reefs:** Similar to fringing reefs in that they also parallel the coastline. They separated by deeper, wider lagoons. Example: Great Barrier Reef, Australia.
- **Atolls:** These are rings of reefs located in the open ocean. They form when fringing reefs grow around volcanic islands that eventually sink into the ocean or the sea level rises around them. Lagoon is always found in the middle. Examples: French Polynesia, the Caroline and Marshall Islands, Micronesia, Cook Islands and Kiribati (Pacific Ocean), Chagos Archipelago (India Ocean)

Significance of Coral Reefs

Coral reefs are among the most biologically diverse and valuable ecosystems on Earth. One of the reasons that coral reefs are so highly valued is because they serve as a center of activity for marine life. An estimated 1 billion people worldwide benefit from the many ecosystem services coral reefs provide including food, coastal protection, and income from tourism and fisheries.

- **Biodiversity (Supporting Services):** Occupying **less than one percent of the ocean floor**, coral reefs are **home to more than 25%** of all marine life.

- **Coastal Protection (Regulating Services):** Healthy coral reefs are the first line of defense for millions of coastal inhabitants globally. They reduce wave energy, act as barriers to storms, prevent catastrophic erosion and stave off flooding, particularly in small island states and atoll nations.
- **Food (Provisioning Services):** They are a **primary source of food** and protein for many coastal communities. If properly managed, coral reefs can yield an average of 15 tons of fish and other seafood per square kilometer per year. Coral reefs support 6 million fishers in nearly 100 countries.
- **Medicine:** Many organisms found on reefs **produce chemical compounds** that have been used in treatments for cardiovascular diseases, ulcers, leukemia, lymphoma, and skin cancer etc.
- **Tourism (Cultural Services):** The economic contribution of tourism to coral reefs is estimated at $36 billion to the global economy each year.
- **Carbon Sequestration:** Coral reefs are an **important reservoir of carbon** and help in the sequestration of ocean carbon.

Major Threats to Coral Reefs

Natural Threats:

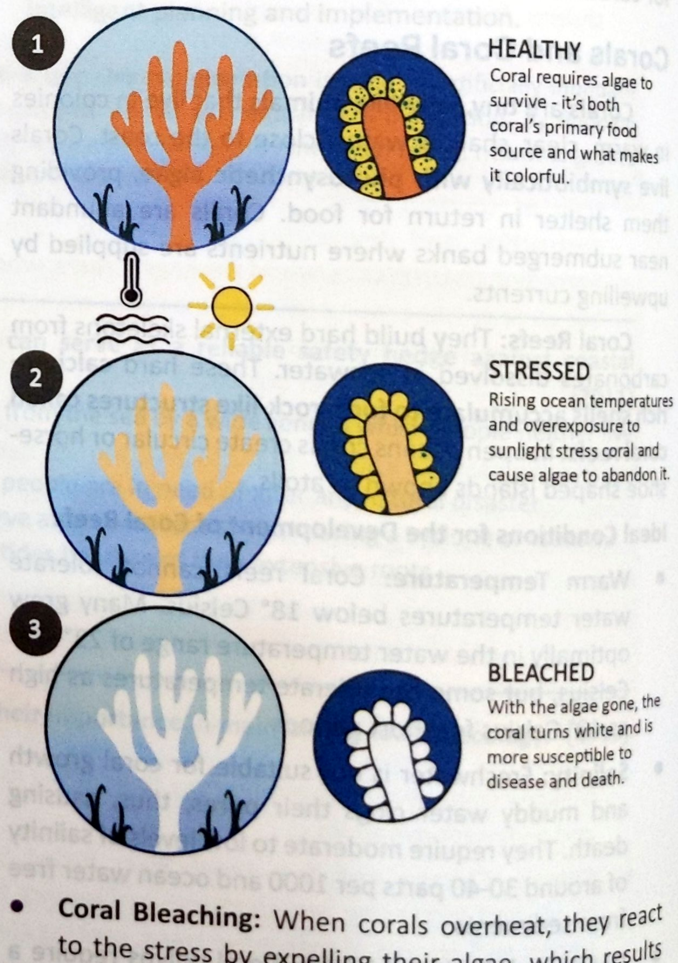
- **Predators:** Predators such as parrotfish, barnacles, crabs and crown-of-thorns starfish, affect the life of coral reefs. The population explosion of the sea star 'Acanthaster planci' can destroy large areas of reef. As per UN report, one third of the reefs of the Great Barrier Reef have been destroyed by the sea star.
- **Hurricanes:** Hurricanes or prolonged cold and rainy weather can harm coral reefs.
- **El Niño:** The El Niño weather pattern, which can result in lower sea level, altered salinity due to increased rainfall, and elevated sea-surface temperatures, can also damage coral
- **Diseases:** Black band disease and white band disease that affect corals may cause local die-offs.
- **Organisms:** Some fungi, sponges, and snails are capable of boring into the limestone of coral reefs.

Local Threats

- **Overfishing and Unsustainable Fishing**: When herbivorous fish that eat seaweed are overfished, uncontrolled seaweed growth can smother coral. Further, damaging fishing techniques such as deep-water trawling and the use of explosives and cyanide, can physically destroy entire sections of coral reefs. For example, blast fishing destroys 64 square feet (5.9 square meters) of reef with a single blast.
- **Coastal Development**: It results in coastal erosion, and the runoff containing the excess sediment can block the light needed for the growth of zooxanthellae. Nutrient-rich fertilizer runoff and sewage effluent can boost algae growth, which starves the water of oxygen, causing eutrophication.
- **Pollution**: Pollution from land, including hot water releases from power plants, pathogens, and trash from marine activities endangers coral reefs.
- **Careless Tourism**: Careless divers often trample on corals or break off pieces as souvenirs. In addition, corals and tropical fish are harvested for the aquarium trade.

Impact of Climate Change

How a coral becomes bleached ?

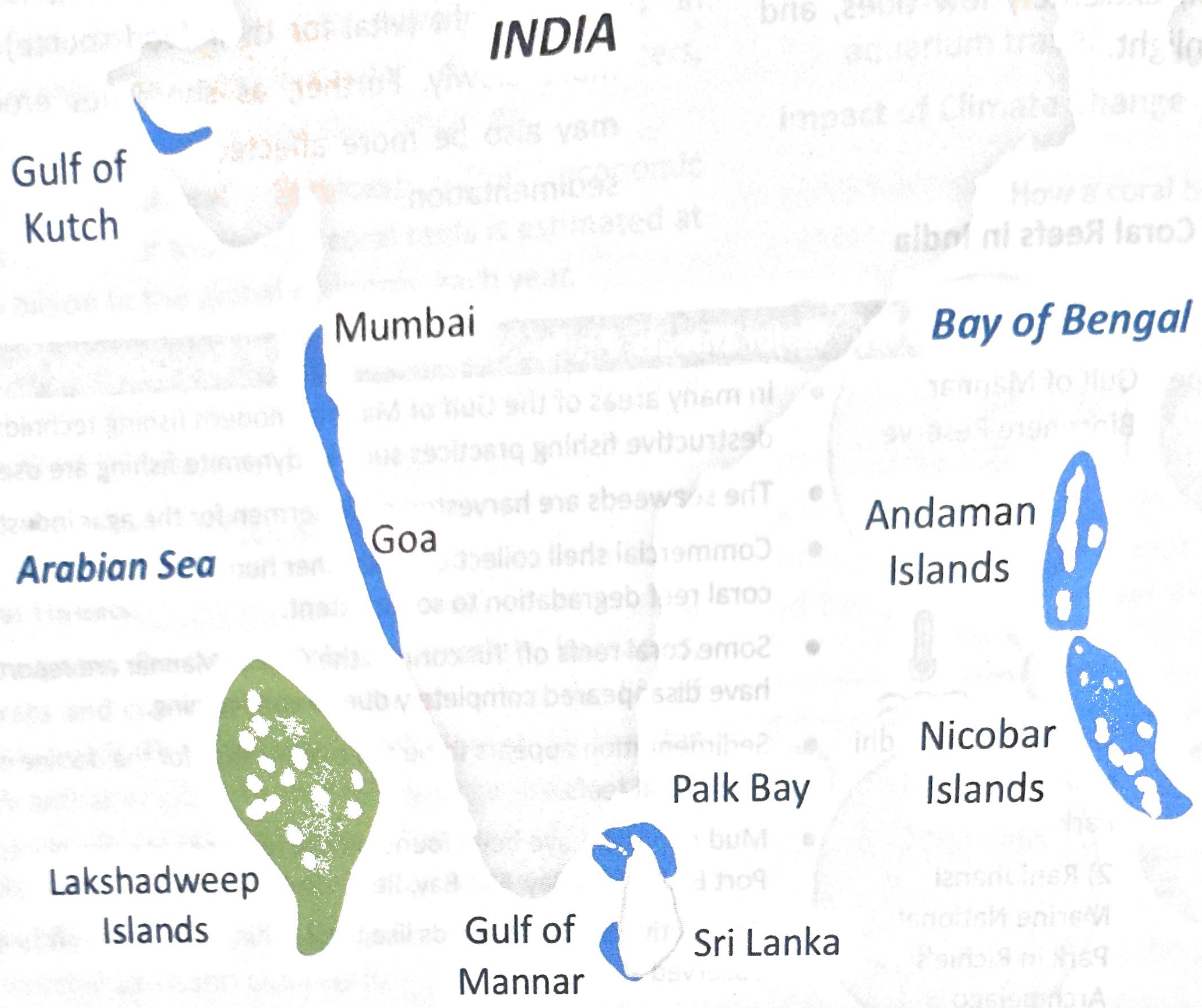

1
HEALTHY
Coral requires algae to survive - it's both coral's primary food source and what makes it colorful.
2
STRESSED
Rising ocean temperatures and overexposure to sunlight stress coral and cause algae to abandon it.
3
BLEACHED
With the algae gone, the coral turns white and is more susceptible to disease and death.

- **Coral Bleaching:** When corals overheat, they react to the stress by expelling their algae, which results in corals turning white. Bleaching leaves corals vulnerable to disease, stunts their growth, affects their reproduction, and can impact other species that depend on the coral communities. Severe bleaching kills them.

- According to the special report "The Ocean and Cryosphere in the Face of Climate Change" published by the Intergovernmental Panel on Climate Change (IPCC) in September 2019, the ocean has absorbed more than 90% of the heat accumulated in the atmosphere by the greenhouse effect since the industrial revolution. The average temperature of tropical oceans has increased by 0.1° C over the past century. This has resulted in extensive coral bleaching around the world. Major Coral Bleaching events (especially in the Great Barrier Reef) occurred in 1998, 2002, 2016, 2017 and 2020.
- Other factors that can cause bleaching include runoff and pollution, extremely low tides, and over exposure to sunlight.
- **Ocean Acidification:** As C02 levels rise and acidification increases, the biodiversity of coral reefs drops, resulting in the elimination of key species needed for healthy reef formation. Acidification also reduces the water's carrying capacity for calcium carbonate that corals need to build their skeletons. Some reefs have already begun to dissolve and it's estimated that by 2050, only 15 percent of coral reefs will have enough calcium carbonate for adequate growth.
- **Rise in Sea Level:** Corals are predicted to end up in deeper water, which means they will receive less sunlight (vital for their food source) and grow more slowly. Further, as shorelines erode, corals may also be more affected by polluted runoff and sedimentation.

Distribution and Threats to Coral Reefs in India

	Reef Type	Coral Reserve	Major Threats
Gulf of Mannar	Fringing type	Gulf of Mannar Biosphere Reserve	• In many areas of the Gulf of Mannar modern fishing techniques and destructive fishing practices such as dynamite fishing are used. • The seaweeds are harvested by fishermen for the agar industry. • Commercial shell collection is another human activity which causes coral reef degradation to some extent. • Some coral reefs off Tuticorin in the Gulf of Mannar are reported to have disappeared completely due to coral mining.
Andaman and Nicobar Islands	Fringing And Barrier type	1) Mahatma Gandhi Marine National Park 2) Rani Jhansi Marine National Park in Richie's Archipelago	• Sedimentation appears to be the major cause for the decline of most coral reefs. • Mud deposits have been found on the reef area at a few places near Port Blair, Navy Bay, Flat Bay, Reef Island, etc. • Destructive fishing methods like blast fishing and cyanide fishing are observed.
Lakshadweep Islands	Atolls	________	• The major threats to the reefs and biodiversity in Lakshadweep Islands are natural processes like sea erosion, siltation and predation by star fish like Acanthaster planci which causes white band disease in the coral reefs. • The anthropogenic (human induced) disturbances pose serious threats to the coral reefs like construction and development along the coasts, removal of natural vegetation, sea grasses, etc.
Gulf of Kutch	Fringing type	Gulf of Kutch Marine National Park	• Some of the threats to the coral reefs in Gulf of Kutch are pollution caused by oil spills, industrial discharge, over collection of fauna, shell collection, mangrove damage and over fishing is damaging the ecosystem. • Coral reefs are damaged by the sand that is being dredged for the cement industry.



Coral Reefs in India

Why there are no coral reefs Bay of Bengal along the northeast coast?

The absence of reefs in Bay of Bengal along the northeast coast is due to the immense quantity of freshwater and silt brought by the rivers such as Ganga, Krishna and Godavari.

Global Initiatives for Conservation of Coral Reefs

- **Global Coral Reef Alliance:** It is a global alliance comprising scientists, divers, environmentalists, and various individuals and organizations who are dedicated to the conservation and protection of coral reefs.
- **International Coral Reef Initiative (ICRI):** Established in 1994, it is an informal partnership among nations, international organizations and non-government organizations to help protect coral reefs globally.
- **Global Coral Reef Monitoring Network (GCRMN):** It is an operational network of the ICRI. It aims to provide the scientific information on the status and trends of coral reef ecosystems for their conservation and management.

- The GCRMN released the **Status of Coral Reefs of the World 2020 Report**. According to the report, 14% of world's corals were lost in last 10 years due to global warming.
- **Global Fund for Coral Reefs:** It is the first UN fund dedicated to SDG 14, 'Life Below Water' and the only global blended finance instrument to mobilize action and resources to protect and restore coral reef ecosystems.

Indian Initiatives for Conservation of Coral reefs

- **Legal Protection**: Corals are protected under the Schedule I of the Wildlife Protection Act, 1992. Further, all types of coral reefs are protected under the Coastal Regulation Zone 1 category. Section 7 (2) of the CRZ prohibits the construction of beach resorts or hotels on coral reefs.
- **Establishment of Marine Protected Areas**: India has designated several marine protected areas to safeguard coral reefs and associated marine ecosystems. For example, the Gulf of Mannar Marine National Park.
- **Conservation and Restoration Programmes**: Institutions like CSIR-National Institute of Oceanography (NIO) have taken several initiatives to restore coral reef habitats through transplantation of coral fragments, artificial reef structures, and coral nursery programs. For example, since 2017, **Reef Watch Marine Conservation** has been involved in a project in the Andaman Islands, wherein they have transplanted coral fragments on to nine artificial structures.

Biorock Technology

Also known as mineral accretion technology, it is a method used to enhance the growth and resilience of coral reefs and other marine ecosystems. Biorock is formed by electro accumulation of minerals dissolved in seawater on steel structures that are lowered onto the sea bed and are connected to a power source. These structures are used as a base for coral and other marine organisms to grow upon. India's first biorock coral restoration project was taken up in the Gulf of Kutch off the Gujarat coast.

CHAPTER 12

CONSERVATION OF WETLANDS

CONSERVATION OF WETLANDS

According to Ramsar Convention's Article 1, wetlands encompass various types of areas such as marshes, fens, peatlands, and bodies of water, whether natural or man-made, that can be permanent or temporary, with water that can be stagnant or flowing. These wetlands can be found in both freshwater and saltwater environments, including coastal areas with water depths not exceeding six meters during low tide. Wetlands experience periodic flooding from the adjacent deepwater habitats and therefore, support plants and animals specifically adapted to such shallow flooding or water logging.

Types of Wetlands

On the basis of their location, wetlands are categorized into- **Inland and Coastal.**

- **Inland Wetlands:** These wetlands are located in the interior of the continents away from the coastal areas. The Inland wetlands are further divided on the basis of their formation:
    - **Natural Inland Wetlands:** These wetlands are formed naturally without any human intervention such as lakes, ponds, ox-bow lakes, waterlogged, etc.
    - **Man-made Inland Wetlands:** These wetlands are formed through human intervention. For example, reservoirs, tanks, Ash ponds, etc.
- **Coastal Wetlands:** These are found along the coastlines of continents and islands. They are also further divided into natural and manmade based on their formation
    - **Natural Coastal Wetlands**: Estuaries, lagoons, creeks, backwaters, coral reefs, mangroves, bays, tidal flats, salt marshes, etc. are examples of natural coastal wetlands
    - **Man-made Wetlands**: Salt pans and aquaculture are examples of man-made coastal wetlands.

Lakes vs Wetlands

Characteristic	Wetland	Lake
Size and Depth	Smaller and shallower	Larger and deeper
Water Source	Fed by surface water such as rain or snowmelt and groundwater	Fed by streams, rivers or underground sources
Water Flow	Slow and steady flow of water	Little to no water movement
Water turnover	Permanent or Temporary	Permanent
Dominant Producer	Macrophytes	Phytoplankton
Productivity	High	Low
Food chain	Detritus Food Chain	Grazing Food Chain
Flood Control	Very Significant	Less Significant
Waste Treatment	Yes	No

Significance of Wetlands

Wetlands are known as the **Kidney of the Earth** as they hold immense significance for maintaining a balance in the ecosystem, including:

- **Biodiversity and Habitat:**
    - **Biodiversity Hotspots:** Wetlands are among the most biologically diverse ecosystems on Earth, supporting a wide array of plant and animal species. They provide critical habitats for numerous species, including rare, threatened, and endangered ones.
    - **Nursery Grounds:** Wetlands serve as vital breeding, nesting, and feeding grounds for a variety of aquatic and terrestrial organisms, such as fish, birds, amphibians, reptiles, and insects.
    - **Migration Routes:** Many migratory species rely on wetlands as stopover points during their

long-distance journeys, ensuring their survival and successful completion of migration cycles.

- **Water Regulation and Quality:**
    - **Flood Control:** Wetlands act as natural sponges, absorbing excess water during periods of heavy rainfall or flooding. They help reduce flood damage by slowing down and storing water, thus mitigating the impacts on surrounding areas.
    - **Water Filtration:** Wetlands act as natural filters, removing pollutants, sediments, and excess nutrients (e.g., nitrogen and phosphorus) from water. This filtration process improves water quality and helps protect downstream ecosystems, including lakes, rivers, and coastal areas.
    - **Groundwater Recharge:** Wetlands contribute to replenishing groundwater by allowing water to percolate through the soil, enhancing the availability of freshwater resources.
- **Climate Regulation:**
    - **Carbon Sequestration:** Wetlands are significant carbon sinks, storing large amounts of organic matter. They help mitigate climate change by sequestering carbon dioxide from the atmosphere, reducing greenhouse gas emissions.
    - **Methane Emissions:** Certain types of wetlands, such as peatlands and marshes, are known to emit methane, a potent greenhouse gas. However, they also provide opportunities for methane mitigation strategies, such as restoration and sustainable management practices.
- **Ecosystem Services and Human Well-being:**
    - **Fisheries and Food Security:** Wetlands support commercial and subsistence fisheries, contributing to local economies and food security. They provide spawning grounds and feeding areas for fish, shellfish, and other aquatic species.
    - **Recreation and Tourism:** Wetlands offer recreational opportunities, including birdwatching, boating, fishing, hiking, and photography. They attract tourists and contribute to local economies through ecotourism and nature-based activities.
    - **Cultural and Indigenous Values:** Wetlands hold significant cultural and spiritual value for many indigenous communities, who have deep connections and traditional knowledge associated with these ecosystems. Preserving wetlands supports cultural heritage and the rights of indigenous peoples.
- **Resilience and Disaster Risk Reduction:**
    - **Coastal Protection:** Wetlands such as mangroves, salt marshes, and seagrass beds act as natural barriers against storm surges, erosion, and coastal flooding. They help protect coastlines, infrastructure, and communities from the impacts of climate-related events.
    - **Resilience to Climate Change:** Healthy wetland ecosystems contribute to the overall resilience of landscapes and communities by regulating water flow, buffering against extreme weather events, and adapting to climate change impacts.

Wetlands and SDGs

The wetlands can play an important role in achieving various sustainable goals-

SDG	Role of Wetland
SDG 6: Clean Water and Sanitation	Wetlands contribute to water purification, filtration, and regulation, improving water quality and availability. They act as natural filters, removing pollutants and excess nutrients from the water.
SDG 13: Climate Action	Wetlands play a role in climate change mitigation and adaptation. They sequester carbon dioxide, mitigating greenhouse gas emissions. Wetlands also act as buffers against storms, floods, and sea-level rise, enhancing the resilience of ecosystems and communities.
SDG 14: Life Below Water	Wetlands, particularly coastal and marine wetlands, provide critical habitats for marine and aquatic species. They support fish populations, contribute to biodiversity, and serve as spawning and nursery grounds for various marine organisms.
SDG 15: Life on Land	Wetlands are part of terrestrial ecosystems and contribute to their biodiversity and ecological integrity. They support diverse flora and fauna, including endangered species, and help maintain healthy ecosystems through their water regulation and filtration functions.

Threats to Wetlands:

Despite their significant role in the environment, they are continued to be impacted by natural and anthropogenic factors, that can have detrimental consequences on ecological integrity. Some of the threats are:

- **Habitat Loss and Degradation:**
  - **Conversion for Agriculture:** Wetlands are often converted for agricultural purposes, leading to habitat loss. In India, the conversion of wetlands for rice cultivation has been a major concern. According to the Indian government's report, "Status of Wetlands in India," the country lost around 38% of its wetlands between 1991 and 2011.
  - **Urbanization and Infrastructure Development:** Rapid urbanization and infrastructure development result in the loss of wetland habitats. For instance, the construction of roads, buildings, and industrial zones can lead to the filling or encroachment of wetlands. In Chennai, the Pallikaranai Marsh, a significant wetland, has been severely impacted.
- **Pollution and Contamination:**
  - **Industrial and Municipal Discharges:** Discharge of untreated or poorly treated industrial effluents and sewage into wetlands leads to water pollution and degradation of water quality. The wetlands around Bellandur Lake in Bangalore have been heavily polluted due to the release of untreated sewage and industrial waste.
  - **Agricultural Runoff:** Excessive use of fertilizers and pesticides in agricultural practices results in nutrient runoff, leading to eutrophication and harmful algal blooms in wetlands. The Vembanad-Kol Wetland in Kerala has faced eutrophication issues due to agricultural runoff.
- **Invasive Alien Species:** Invasive alien species, such as water hyacinth (Eichhornia crassipes) and the water lettuce (Pistia stratiotes), can outcompete native vegetation, alter the hydrology, and disrupt the ecological balance of wetlands. The Dal Lake in Srinagar has been affected by the invasive water hyacinth, which has caused ecological imbalances and impacted the lake's biodiversity.
- **Climate Change Impacts:**
  - **Sea Level Rise:** Rising sea levels due to climate change pose a threat to coastal wetlands, including mangroves and salt marshes. Sundarbans, a UNESCO World Heritage Site shared by India and Bangladesh, is at risk due to rising sea levels.
  - **Altered Precipitation Patterns:** Changes in rainfall patterns can affect wetland hydrology, leading to water scarcity or flooding. Keoladeo National Park in Rajasthan, a Ramsar site, has experienced fluctuations in water availability, affecting the migratory bird population.
- **Unsustainable Resource Use:**
  - **Overfishing:** Unsustainable fishing practices can deplete fish stocks and disrupt the ecological balance in wetlands. Chilika Lake in Odisha, has faced challenges related to overfishing.
  - **Sand Mining:** Unregulated sand mining in wetland areas can alter the hydrology, degrade habitats, and disrupt ecosystem functioning. The Thane Creek Flamingo Sanctuary near Mumbai has witnessed the adverse impacts of sand mining on its wetland ecosystem.

Global Initiatives to Conserve Wetlands

Wetlands are some of the world's most productive and diverse ecosystems but are also under threat from human activities such as urbanization, agriculture, and resource extraction. Hence, their constant conservation is the need for time. Various initiative has been taken at the global and at national level to conserve the wetlands

Ramsar Convention

It an international treaty that was signed in 1971 in the Ramsar city of Iran and came into force in 1975. It aims to promote the conservation and sustainable use of wetlands. It has been ratified by 170 countries (including India), making it one of the most successful international environmental treaties.

- **Ramsar Sites:** It is a wetland site designated to be of international importance. These wetlands are protected under strict guidelines of the Ramsar Convention on Wetlands.
  - Any wetland to be declared a wetland of international importance should support vulnerable
  - endangered or threatened species and attract more than 20,000 or more water birds.
  - The declaration would provide an opportunity to seek international technical support for conservation and sustainable use of wetland through participatory mechanism.

- It would also ensure international co-operation and financial assistance for wetland conservation.

Montreux Record

It was established by the Ramsar Convention on Wetlands in 1990. It is a register which lists wetland sites that are facing or have the potential to face significant environmental changes. These changes could be due to human activities such as technological developments, pollution, or other human interference.

- **Significance:** Wetlands included in the Montreux Record receive international attention and assistance to ensure their conservation and sustainable use. The record serves as a tool to raise awareness about the vulnerable state of these wetland sites and encourage collaborative efforts for their protection and management.

World Wetlands Day

It is celebrated on the 2nd of February every year to mark the date of the adoption of the Ramsar Convention. It is used to create awareness among the people and educate them about the wise use of wetlands.

Indian Initiatives to Conserve Wetlands

- **Wetlands (Conservation and Management) Rules, 2017**: It provides statutory protection to the wetlands in India, and their development, usage, and protection are regulated by these rules. Moreover, it creates state-level bodies to protect the wetlands at the state level and creates a National Wetland Committee as an advisory body to protect wetlands.
- **Action Plan of MoEFCC:** The Ministry of Environment, Forest and Climate Change (MoEFCC) supports the implementation of management action plans for over 250 wetlands under schemes such as the National Plan for Conservation of Aquatic Ecosystems, Mangroves and Coral Reefs, and Integrated Development of Wildlife Habitats.
- **Designation of Wetland sites under Ramsar Convention:** India has designated 75 wetland sites in India under the Ramsar Convention for their sustainable use and coordinated protection.

Ramsar Sites in India.

Site Name	State Location	About
Kolleru Lake	Andhra Pradesh	● It is one of the largest freshwater lakes in India. ● It is fed by several tributaries of the river Krishna. ● It is a naturally occurring eutrophic lake. ● It also serves as a flood control reservoir between the deltas of the Godavari and Krishna rivers ● **Area- 901.00 sq. km.** ● **Declaration- 19.8.2002**
Deepor Beel	Assam	● It is a permanent freshwater lake in the old Brahmaputra River channel. ● It is also a staging site on migratory flyways. ● Some globally threatened bird species such as Spot-billed Pelican, Lesser and Greater Adjutant Stork, and Baer's Pochard are found here. ● Threatened as it has now become a dumping site. ● **Area-40.00 sq. km.** ● **Declaration-19.8.2002**
Kabartal Wetland	Bihar	● Also known as Kanwar Lake or Kabar Taal. ● It is Asia's largest freshwater oxbow lake. ● It serves as a significant flood buffer and provides livelihood opportunities to the locals. ● The Wetland is an important stopover along the Central Asian Flyway, with 58 migratory waterbirds using it to rest and refuel. ● It is also home to Critically endangered Oriental white-backed vultures and Long-billed vulture species. ● **Area-26.20 sq. km.** ● **Declaration-21.07.2020**

Site Name	State Location	About
Nanda Lake	**Goa**	• It is made up of sporadic freshwater marshes. • It helps in the cultivation of rice and supports fishing and recreation. • Notable bird species include black-headed ibis, common kingfisher, wire-tailed swallow, and bronze-winged jacana. • **Area-0.42sq.km.** • **Declaration-06.08.2022**
Khijadia Wildlife Sanctuary	**Gujarat**	• Situated on the southern Gulf of Kutch coast in Gujarat. • It belongs to Gujarat state's Important Bird Areas (IBA). • It is home to over 200 bird species, including several migratory bird species that visit the sanctuary during the winter months. • On one side, the Khijadiya Wildlife Sanctuary connects to the Marine National Park, and on the other, the Dhunvav River discharges fresh water into it. • **Area-5.12 sq. km.** • **Declaration-13.04.2021**
Nalsarovar Bird Sanctuary	**Gujarat**	• It primarily consists of a large lake and ambient marshes. • It is the largest wetland bird sanctuary in Gujarat. • An endangered Indian Wild Ass satellite population depends on the wetland for survival. • It also supports migratory birds population such as rosy pelicans, flamingoes, white storks, brahminy ducks, and herons. • **Area-120.00 sq. km.** • **Declaration-24.09.2012**
Thol Lake Wildlife Sanctuary	**Gujarat**	• It is a shallow freshwater lake in the Mehsana district. • It is an artificial wetland. • It is surrounded by marshes and scrubland. • It is located on the Central Asian Flyway and is home to more than 320 different species of birds, some important ones are flamingos, pelicans, and sarus cranes. • **Area-6.99 sq. km.** • **Declaration-05.04.2021**
Wadhvana Wetland	• **Gujarat**	• Water from the River Orsang pours into the lake and meets the Narmada River at Chandod. • Important bird species here are the black-winged stilt, pied avocet, redshank, and northern pintail • Fauna here consists of nilgai, jackals, and Indian foxes. • During the winter, it frequently records the red-crested pochard (Netta rufina), a duck that is otherwise uncommon in Western India • **Area-6.30 sq. km.** • **Declaration-05.04.2021**
Bhindawas Wildlife Sanctuary	**Haryana**	• It is a man-made freshwater wetland. • It is an important habitat for the endangered sarus crane. • Other bird species found at the sanctuary include painted storks, black-necked storks, grey herons, and Indian cormorants. • The sanctuary is also home to several mammal species such as nilgai, jackals, and wild boars. • **Area-4.12 sq. km.** • **Declaration-25.05.2021**

Site Name	State Location	About
Sultanpur National Park	Haryana	• Also known as Sultanpur Bird Sanctuary and is essentially a bird watcher's paradise. • It is home to more than 250 species of birds including both resident and migratory. • More than ten species of birds that are internationally endangered can be found here, including the severely endangered sociable lapwing, the endangered Egyptian vulture, Saker Falcon, Pallas's Fish Eagle, and the Black-bellied Tern. • **Area-1.43 sq. km.** • **Declaration-25.05.2021**
Chandertal Wetland	Himachal Pradesh	• It is a high-altitude (14100ft.) lake and is located in the Lahul and Spiti regions. • It is also known as the Lake of the Moon. It is a popular tourist destination for camping, trekking, and hiking. • The lake is also a significant site for Hindu pilgrims, who believe that it is the site where Lord Indra's chariot picked up Yudhishthira, the eldest Pandava, to take him to heaven. • **Area-0.49 sq. km.** • **Declaration- 8.11.2005**
Pong Dam Lake	Himachal Pradesh	• It is situated in the Beas River in the low Himalayan Foothills. • It is a man-made water storage reservoir that was built in the year 1975. • It is also known by the name Maharana Pratap Sagar. • The reservoir was declared as a bird sanctuary in 1983. • Important bird species here are- bar-headed goose, northern lapwing, ruddy shelduck, etc. • **Area-156.62 sq. km.** • **Declaration- 19.8.2002**
Renuka Wetland	Himachal Pradesh	• It is the largest lake in Himachal Pradesh. • It is located 672m above sea level. • It is a natural wetland with inland underground karst structures and freshwater springs. • It derives its name from the local goddess Renuka ji. • **Area-0.20 sq. km.** • **Declaration-8.11.2005**
Hokera Wetland	Jammu and Kashmir	• It is situated in the Jhelum River basin in the Kashmir Valley. • It is a high-altitude wetland that lies 5,197 ft above sea level. • The reserve is fed by the two perennial inlet streams- Doodhganaga from the east and Sukhnag from the west. • It is also a designated bird sanctuary in J&K. • **Area-13.75 sq.km.** • **Declaration-8.11.2005**
Hygam Wetland Conservation Reserve	Jammu and Kashmir	• It is located within the Jhelum River basin and connected to another Ramsar site that is Wular lake. • It is part of the Central Asian Flyway and around 40,000 birds are recorded here annually. • It plays a significant role in flood control, aquifer recharge, and regulating the water flow of Wular Lake. • The wetland also supports mammals, amphibians, and fish including Eurasian otters, common carp, and common pochard. • **Area-8.02 sq. km.** • **Declaration-13.08.2022**

Site Name	State Location	About
Shallbugh Wetland Conservation Reserve	Jammu and Kashmir	- It is a shallow wetland and is primarily fed by rainfall, snowmelt from the Kashmir Himalayas, and stream water flowing from the Sindh River and Anchar Lake. - It is situated close to another Ramsar Site, Hokera Wetland, and together they form an important aquatic habitat in this region. - It is an important habitat for over 21 species of resident and migratory birds, some important ones are the steppe eagle, Pallas's fish-eagle, and black-bellied tern. - **Area-16.75 sq. km.** - **Declaration-13.08.2022**
Surinsar-Mansar Lakes	Jammu and Kashmir	- These are twin lakes that are interconnected to each other. - They are believed to have been formed by the same seismic activity that created the Himalayan range. - They are considered to be sacred by the locals and are associated with several Hindu legends. Temples including Surinsar Temple and the Mansar Temple are situated here. - **Area-3.50 sq. km.** - **Declaration-8.11.2005**
Wular Lake	Jammu and Kashmir	- It is the largest freshwater lake in India. - It is fed by the river Jhelum and several small streams. - The lake had a rich history and is also mentioned in the Rajatarangini. - Important source of livelihood for the local population through fishing, agriculture, and tourism. - The Biodiversity includes the common otter, muskrat, and several species of migratory birds. - At the mouth of Wular Lake, there is a "navigation lock-cum-control structure" called The Tulbul Project. - **Area-189.00 sq. km.** - **Declaration-23.3.1990**
Ranganathittu Bird Sanctuary	Karnataka	- It is a riverine wetland and comprises six islets on the banks of the Kaveri River. - These islets were formed when an embarkment was built between 1645 and 1648 across the river Kaveri. - It is an ecologically rich site and supports healthy populations of mugger crocodile, smooth-coated otter, and hump-backed mahseer. - It is also classified as an Important Bird and Biodiversity Area (IBA) and supports over 1% of the global population of painted storks, spot-billed pelicans, and black-headed ibis. - During winter months, as many as 40,000 birds congregate at the site, some migrating from Siberia, and Latin America. - **Area-5.18 sq. km.** - **Declaration- 15.02.2022**
Asthamudi Wetland	Kerala	- This location has natural backwaters that create suitable conditions for the significant wetland site. - The river Pallichal and River Kallada drain into it. - It provides suitable habitat to 57 species of birds (including 6 migratory) and around 100 species of fish. - It is the source of livelihood for thousands of fishermen in the region. - But, the rising population and unsustainable urbanization are posing threat. - **Area-61.40 sq.km.** - **Declaration-19.8.2002**

Site Name	State Location	About
Sasthamkotta Lake	**Kerala**	• It is named after the ancient Sastha temple (a pilgrimage center) located on its bank. • It meets the drinking water requirement of local people as the water in the lake is free of common salt or other minerals and metals. • It is also home to the Critically endangered Puntius ticto punctatus specie. • **Area-3.73 sq.km.** • **Declaration-19.8.2002**
Vembanad Kol Wetland	**Kerala**	• It is the largest brackish, humid, tropical wetland ecosystem on the southwest coast of India. • It receives water from ten rivers. • The Kol region is home to about 90 species of resident birds and 50 kinds of migratory birds. • It is very significant as provides protection to three districts from the flood. • **Area-1512.50 sq.km.** • **Declaration- 19.8.2002**
Tso Kar Wetland Complex	**Ladakh**	• It is a high-altitude wetland of global importance situated 4500 meters above sea level in the Changthang region of Ladakh. • It is a fluctuating salt lake. • It is home to several rare and endangered species such as the black-necked crane, bar-headed goose, and Tibetan wolf. • The wetland is also an important breeding and nesting ground for several migratory bird species. • **Area-95.77 sq. km.** • **Declaration-17.11.2020**
Tsomoriri Lake	**Ladakh**	• It is also known as lake moriri or mountain lake. • Situated in the Changthang Plateau of Ladakh. • It is a high-altitude Ramsar site that is located 4,522 meters above sea level. • It is a saline lake. • It is a breeding ground for several migratory bird species, including the bar-headed geese, black-necked cranes, and brahminy ducks. • There are several Buddhist monasteries and shrines located near the lake, including the Korzok Monastery. • **Area-120.00 sq. km.** • **Declaration- 19.8.2002**
Bhoj Wetlands	**Madhya Pradesh**	• In the city of Bhopal, two lakes namely Lower Lake and the Bhojtal make up the wetland. • It is a man-made reservoir and is home to India's largest bird sarus crane. • Apart, it is very rich in biodiversity and home to various species of fishes, birds, reptiles, and amphibians. • **Area-32.01 sq.km.** • **Declaration-19.8.2002**

Site Name	State Location	About
Sakhya Sagar	Madhya Pradesh	• It is a small man-made reservoir. • It was built in 1918 from the Manier River. • It is surrounded by marshes, plantations, and small patches of agricultural land. • In total, the wetland supports 19 species of fish, nine reptiles, and 19 mammals, and is an important staging ground for 73 bird species. • It also plays a significant role in nutrient cycling, groundwater recharge, and regulating the micro-climate of the area. • **Area-2.48 sq. km.** • **Declaration-01.07.2022**
Sirpur Wetland	Madhya Pradesh	• It is a man-made wetland but over the period of 200 years, it has stabilized and developed near-natural characteristics. • It is a shallow, alkaline, nutrient-rich lake that floods during the monsoon to a maximum depth of two meters. • It supports 175 terrestrial plant species, six macrophytes, 30 natural and cultured fish species, eight reptiles, and over 130 species of birds in total. • Further, it provides medicinal plants and acts as a buffer against flooding while helping to regulate the local microclimate. • **Area-1.61 sq. km.** • **Declaration-01.07.2022**
Yashwant Sagar	Madhya Pradesh	• It is a dam reservoir on the Gambhir River in the Indore district. • It was built in the 1930s to provide irrigation and drinking water to the Indore region. • It is one of 19 important Bird Areas in Madhya Pradesh. • Overall, it supports around 239 bird species and 39 species of fish along with other plants and mammals. • It is a significant habitat for the vulnerable sarus crane. • Currently, it is also used for commercial aquaculture. • **Area-8.23 sq. km.** • **Declaration- 13.08.2022**
Lonar Lake	Maharashtra	• It is located in the volcanic basalt rock of the Deccan Plateau. • It was formed by the impact of a meteor strike between 35,000 and 50,000 years ago. • It is one of only four known hyper-velocity impact craters in basaltic rock anywhere on Earth. • It is also a is a notified National Geo-heritage Monument. • Resident and migratory birds such as black-winged stilts, brahminy ducks, grebes, shelducks are found here. • **Area-4.27 sq.km.** • **Declaration-22.7.2020**
Nandur Madhameshwar	Maharashtra	• It is Maharshatra's first Ramsar site. • The Nandur Madhameshwar Weir, which was built at the confluence of the Godavari and Kadwa Rivers, contributed to the development of this thriving wetland. • The Site is a mosaic of lakes, marshes, and riparian forests on the Deccan Plateau. • Its diverse habitats contrast with the surrounding semi-arid conditions caused by the rain shadow of the Western Ghats mountain range. • It hosts some of India's most iconic species, such as the leopard and Indian sandalwood. • Critically endangered species Deolali minnow, Indian vulture, and white-rumped vulture are also found here.. • **Area-14.37 sq. km.** • **Declaration-21.6.2019**

Site Name	State Location	About
Thane Creek	**Maharashtra**	• It is one of the largest creeks in Asia. • It is also designated as an Important Bird and Biodiversity Area (IBAs) and acts as a sanctuary for flamingos and other important bird species. • It is also part of the Central Asia Flyway. • Though the Creek falls under the Marine Ecoregions of the World (MEOW) but it is fed by numerous freshwater sources, making the water brackish, which supports the rich quality of Mangroves. • It acts as a natural buffer against floods, cyclones, and seawater intrusions, enhancing the resilience of surrounding areas to such climate-related hazards. • **Area-65.21 sq. km.** • **Declaration-13.04.2022**
Loktak Lake	**Manipur**	• It is the largest freshwater lake in the Northeast part of India. • It is famous for the phumdi floating over it. • Moreover, the only floating national park in the world, Keibul Lamjao, floats above it. • It is also home to the Endangered Sangai specie. • **Area-266.00 sq. km.** • **Declaration- 23.3.1990**
Pala Wetland	**Mizoram**	• It is the largest natural wetland in the state of Mizoram. • It supports a rich diversity of animal species, including at least seven mammals, 222 birds, 11 amphibians, and 21 reptiles. • The marshy areas here provide suitable habitat for sambar deer, and wild pigs, and barking deer. • Pala Wetland is revered by the local Mara people and has a deep connection with their history. • It is also a major source of freshwater and fishing for the local people. • **Area-18.50 sq.km.** • **Declaration-31.08.2021**
Ansupa Lake	**Odisha**	• It is a freshwater oxbow lake in the horseshoe shape on the left bank of the Mahanadi River. • It supports around 194 species of birds, 61 fish species, 244 macrophytes, 88 butterflies, and 26 mammals. • It also provides habitat to three endangered species - the Indian skimmer, the black-bellied tern, and the wagur. • **Area-2.31 sq. km.** • **Declaration-13.08.2022**
Bhitarkanika Mangroves	**Odisha**	• It is the second largest mangrove forest in India after Sundarbans. • Gahirmatha Beach at the location is thought to be the largest known Olive Ridley sea turtle breeding beach in the world, hosting 500,000 nests each year. • It also boasts the highest concentration of saltwater crocodiles in the nation, with around 700 Crocodylus porosus. • It is also home to 55 species of the total of 58 Mangrove species documented in India. • **Area-650.00 sq. km.** • **Declaration-19.8.2002**

Site Name	State Location	About
Chilka Lake	Odisha	• It is a brackish lake. • It is a crucial habitat for 33 species of water birds. • It also supports 118 different species of fish. • It was placed on the Montreux Record in 1993 and was removed in 2002 as a result of restoration, for which Chilika Development Authority was awarded the Ramsar Wetland Conservation Award in 2002. • **Area-1165.00 sq. km.** • **Declaration-1.10.1981**
Hirakud Reservoir	Odisha	• It is one of the largest man-made reservoirs in India. • It is built across the Mahanadi River by a combination of earth and modern dams. • It moderates the impact of floods in the Mahanadi Delta. • It supports 130 bird species and about 54 fish species. • With a total yield of 480 tonnes per year, the fishery supports the livelihoods of over 7,000 fishermen. • It also produces around 350 megawatts of hydropower and irrigates 436,000 hectares of land. • **Area-654.00 sq. km.** • **Declaration-12.10.2021**
Satkosia Gorge	Odisha	• It is carved by the Mahanadi River and situated within the Satkosia Tiger Reserve. • The Gorge is approximately 22km in length. Notable animal species here are - the red-crowned roofed turtle, Indian narrow-headed softshell turtle, tiger, and black-bellied tern. • It provides ecosystem services such as groundwater recharge flood protection and climate regulation. • **Area-981.97 sq. km.** • **Declaration-10.12.2021**
Tampara Lake	Odisha	• The use of explosives during a battle between the British East India Company and French colonists in 1766 created a large depression which later became Tampara Lake. • It is a freshwater lake situated on the right bank of the Rushikulya River in the Ganjam district. • It supports 60 species of birds and 46 species of fish. • It is a significant wetland in providing water for agriculture and domestic use. • It checks the flood during the monsoon season. • The local population also uses it for the transportation of goods. • Vulnerable species such as common carp, common pochard, and river tern are also found here. • **Area-3.00 sq. km.** • **Declaration-13.08.2022**
Beas Conservation Reserve	Punjab	• It supports several migratory species. • It helps in groundwater recharge. • The Beas River runs through it for 185 kilometers. • Islands, sand bars, and braided canals are scattered across the stretch • **Area- 64.29 sq. km.** • **Declaration- 26.9.2019**

Site Name	State Location	About
Harike Lake	**Punjab**	• It is a small reservoir located where the Sutlej and Beas rivers converge. • Over 200,000 Anatidae (ducks, geese, swans, etc.) use it as a breeding, wintering, and staging area throughout the migration. • **Area-41.00 sq. km.** • **Declaration-23.3.1990**
Kanjli Lake	**Punjab**	• It is situated in the Kapurthala district of Punjab. • It is a man-made wetland (built in 1870) that encompasses kanjli lake. • It is very significant from the religious point of view as it is directly related to the First Guru of Sikhs Guru Nanak Dev Ji. • **Area-1.83 sq. km.** • **Declaration-22.1.2002**
Keshopur-Miani Community Reserve	**Punjab**	• The Reserve is a mosaic of natural marshes, aquaculture ponds, and agricultural wetlands maintained by the annual rainfall runoff. • This site is a great example of how a community-managed wetland can be used to support and sustain the local bio-diversity and provide food and protection to the people. Endangered spotted pond turtles can be found here. • **Area-3.44 sq. km.** • **Declaration- 26.9.2019**
Nangal Wildlife Sanctuary	**Punjab**	• It is situated on the banks of river Satluj and in the foothills of Shiwaliks. • It is home to threatened species, such as the endangered Indian Pangolin, and Egyptian Vulture. • It also attracts tourists throughout the year. • The Nangal Dam is also a part of the sanctuary which allows the flow of a natural ecosystem across the area • **Area-1.16 sq. km.** • **Declaration-26.9.2019**
Ropar Lake	**Punjab**	• It is a man-made freshwater lake built in 1952 by building a barrage to divert water from the Sutlej River for drinking and irrigation supplies. • It is a biologically diverse and rich area that supports 49 local birds, 11 migratory birds, 3 rare birds, and 54 common bird species. • It is an important breeding place for the nationally protected Smooth Indian Otter, Hog Deer, Sambar, several reptiles, and the endangered Indian Pangolin. • Crops like wheat, rice, sugar cane, and sorghum are cultivated in the surrounding area. • **Area-13.65 sq. km.** • **Declaration-22.1.2002**
Keoladeo Ghana NP	**Rajasthan**	• Formerly known as the Bharatpur Bird Sanctuary is a famous avifauna sanctuary in Rajasthan. • It is a collection of 10 man-made seasonal lagoons. • This diverse habitat is home to 366 bird species, 379 floral species, 50 species of fish, 13 species of snakes, 5 species of lizards, 7 amphibian species, 7 turtle species, and a variety of other invertebrates. • It is also a designated National Park. • **Area-28.73 sq. km.** • **Declaration-1.10.1981**

Site Name	State Location	About
Sambhar Lake	**Rajasthan**	- It is the largest inland saltwater lake in India. - The lake receives water from six rivers: Mantha, Rupangarh, Khari, Khandela, Medtha, and Samod. - It is also a key wintering area for tens of thousands of pink flamingos and other birds that migrate from northern Asia and Siberia.It is surrounded by sand flats and dry thorn scrub. - **Area-240.00 sq. km.** - **Declaration-23.3.1990**
Chitrangudi Bird Sanctuary	**Tamil Nadu**	- It is locally known as "Chitrangudi Kanmoli" and is situated adjacent to Kanjirankulam Bird Sanctuary. - During the winter months, several species of migratory birds come here for breeding such as spot-billed pelican, Asian openbill stork, little egret, and great egret. - It is also classified as an Important Bird and Biodiversity Area (IBA). - **Area-2.60 sq. km.** - **Declaration-13.08.2022**
Gulf of Mannar Marine Biosphere Reserve	**Tamil Nadu**	- It is South and Southeast Asia's first Marine Biosphere Reserve. - It is located in the Coromandel Coast region, halfway between Sri Lanka's west coast and India's southeast tip. - It supports 117 species of coral, over 450 fish including four seahorses, 160 birds, 641 species of crustaceans including 38 crabs and two lobsters, four sea turtles, and 11 mangroves. - Globally threatened species such as the dugong, whale shark, green sea turtle, hawksbill turtle, and Indo-Pacific humpback dolphin are also found here. - It is also recognized as a World Heritage Site. - **Area-526.72 sq. km.** - **Declaration-08.04.2022**
Kanjirankulam Bird Sanctuary	**Tamil Nadu**	- The Sanctuary was established in the year 1989 and is adjacent to Chitrangudi Bird Sanctuary. - During the winter months, several migratory species including painted storks, white ibis, black ibis, tiny egrets, and great egrets come here for breeding. - It is a notable nesting site for several migratory heron species. - **Area-0.97 sq. km.** - **Declaration-13.08.2022**
Karikili Bird Sanctuary	**Tamil Nadu**	- Karikili Bird Sanctuary along with Vedanthangal Bird Sanctuary has been identified as one of the Important Bird Areas of Tamil Nadu. - Some important bird species here are the Indian pitta, common kingfisher, little egret, spot-billed duck, and painted stork, among others. - **Area-0.58 sq. km.** - **Declaration- 04.08.2022**
Koonthankulam Bird Sanctuary	**Tamil Nadu**	- It was declared a sanctuary in 1994. - It is composed of Koonthankulam and Kadankulam irrigation tanks, conveniently linked by tar road. - On the Central Asian Flyway, is an Important Bird and Biodiversity Area (IBA). - Notable waterbird species include Indian pond heron, Eurasian wigeon, spot-billed pelican, oriental darter, and Northern pintail. - It is also the largest reserve for breeding water birds in South India. - It also acts as a buffer against flooding during periods of extreme rainfall. - **Area-0.72 sq. km.** - **Declaration-11.08.2021**

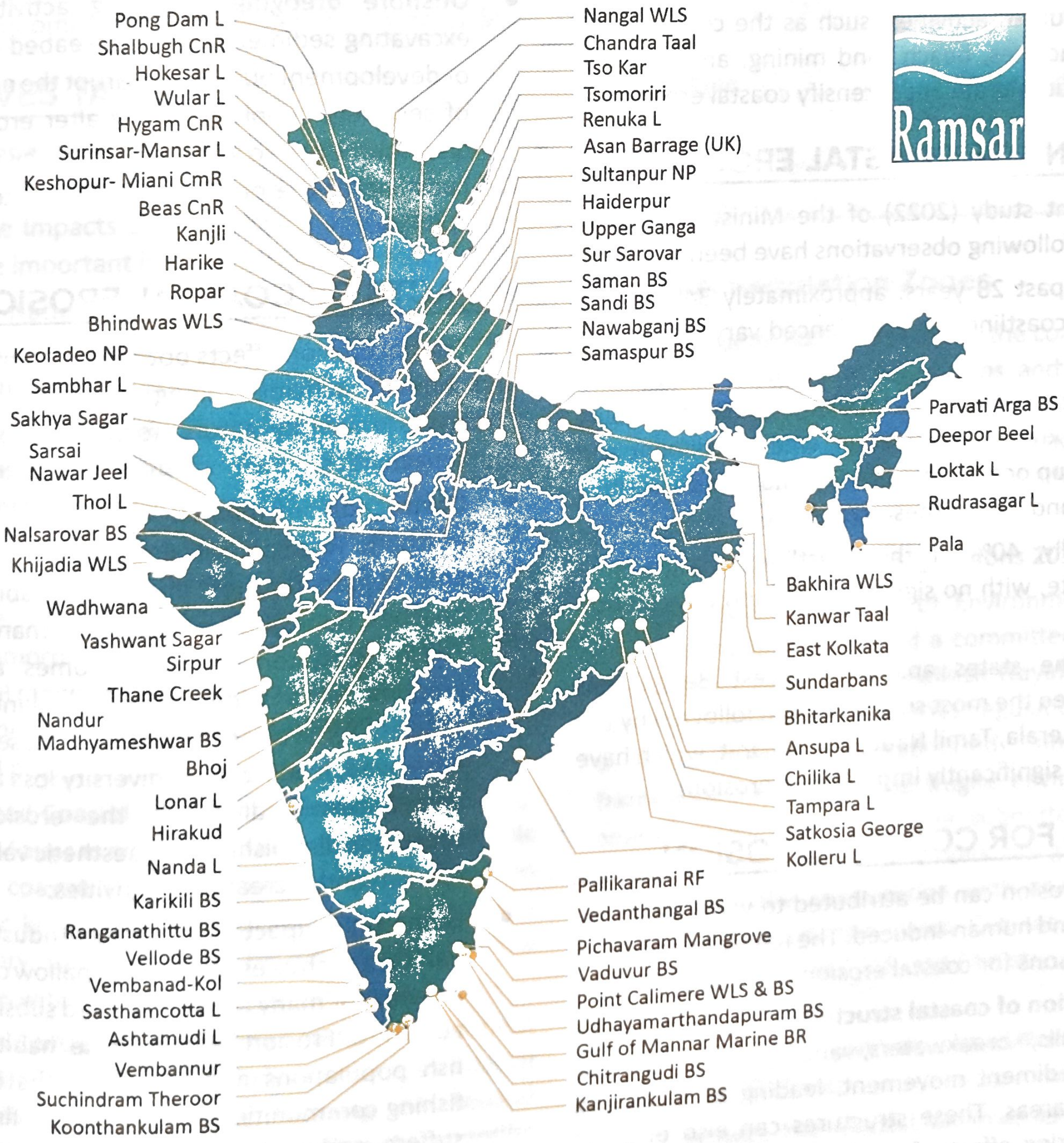
Site Name	State Location	About
Pallikaranai Marsh Reserve Forest	Tamil Nadu	● It is a freshwater marsh in the city of Chennai and situated adjacent to the Bay of Bengal. ● It is the only surviving wetland ecosystem of the city and is among the few and last remaining natural wetlands of South India. ● It is also an important source of groundwater recharge and serves as a natural flood control mechanism. ● It is also an important carbon sink, helping to mitigate the effects of climate change. ● Some important bird species here are painted stork, black-winged stilt, spot-billed pelican, and Asian openbill. ● **Area-12.48 sq. km.** ● **Declaration-04.08.2022**
Pichavaram Mangrove	Tamil Nadu	● It consists of a number of islands interspersing a vast expanse of water covered with mangrove forest. ● It is separated from the Bay of Bengal by a sand bar. ● Some important bird species here are- snipes, cormorants, egrets, storks, herons, spoonbills, and pelicans. ● **Area-14.79 sq. km.** ● **Declaration-04.08.2022**
Point Calimere Wildlife and Bird Sanctuary	Tamil Nadu	● It is one of the few surviving Dry Evergreen Forests. ● A coastal area consisting of shallow waters, shores, long sand bars, intertidal flats, and intertidal forests, chiefly mangrove, and seasonal, often-saline lagoons, as well as human-made salt exploitation sites. ● It is home to the Indian blackbuck. ● It is one of the few known wintering locations of the spoon-billed sandpiper. ● It also supports large wintering populations of greater flamingos. ● **Area-385.00 sq. km.** ● **Declaration-19.8.2002**
Suchindram Theroor Wetland Complex	Tamil Nadu	● The complex comprises two man-made reservoirs, Theroor and Suchindram. ● The Site is part of the Suchindram-Theroor Manakudi Conservation Reserve. ● It is also the southernmost point of the Central Asian Flyway. ● It is also designated as an Important Bird and Biodiversity Area (IBA). ● Further, it supports 250 species of birds, of which 53 are migratory, 12 endemic, and four threatened. ● It also supports the livelihoods of about 75% of the population of the wetland communities. ● **Area-0.94 sq. km.** ● **Declaration- 13.08.2022**
Udhayamar-thandapuram Bird Sanctuary	Tamil Nadu	● The Sanctuary consists of a number of human-made irrigation tanks, interconnected by an ancient network of canals. ● It is fed by the Mettur dam through the Koraiyar canal. ● The Site is also an important staging and breeding ground for several species of waterbirds. ● Notable species observed include the oriental darter, black-headed ibis, Eurasian wigeon, Northern pintail, and garganey. ● It stores the floodwaters during the monsoon season and maintains surface water flow during drier periods. ● **Area-0.44 sq. km.** ● **Declaration-04.08.2022**

Site Name	State Location	About
Vaduvur Bird Sanctuary	**Tamil Nadu**	• Established in 1999, it is composed of small man-made reservoirs interconnected by an ancient network of canals and fed by the Mettur reservoir. • The interconnected system of wetlands checks floods and also provides water during the dry season. • It provides habitat to around 118 bird species, including spot-billed pelican, black-headed ibis, Eurasian wigeon, and northern pintail. • It has also been identified as an area of national importance by the national government. • **Area-1.13 sq. km.** • **Declaration-13.08.2022**
Vedanthangal Bird Sanctuary	**Tamil Nadu**	• It is a small irrigation tank in Vedanthangal village of Tamil Nadu. • It is surrounded by rocky plains and low-ridged, denuded hillocks. • It is also an Important Bird and Biodiversity Area (IBA) and is home to several species of birds such as the black-headed ibis, Eurasian spoonbill, black-crowned night heron, and painted stork. • It plays a significant role in nutrient recycling and groundwater recharge. • It is a tourist destination, which generates revenue for the local population. • **Area-0.40 sq. km.** • **Declaration-04.08.2022**
Vellode Bird Sanctuary	**Tamil Nadu**	• It is a man-made tank and is surrounded by semi-dark bushes. • It is an important staging and breeding ground for migratory birds on the Central Asian Flyway. • It also provides drinking water and livelihood to the local population. • **Area-0.77 sq. km.** • **Declaration- 04.08.2022**
Vembannur Wetland Complex	**Tamil Nadu**	• It is a man-made water tank, situated near the southernmost point of mainland India. • It also forms part of an Important Bird and Biodiversity Area (IBA). • It provides suitable habitat to several species of waterbirds such as the Indian river tern, the spotted greenshank, the garganey, and the grey pelican. • It also provides fresh water and fish to the local communities and moderates the impact of floods and droughts in the region. • **Area-0.20 sq. km.** • **Declaration-04.08.2022**
Rudrasagar Lake	**Tripura**	• It is the only Ramsar site in Tripura. • It is a natural sedimentation reservoir, which receives flow from three perennial streams namely, Noacherra, Durlavnaraya cherra, and Kemtali cherra. • It provides suitable habitat for the IUCN Red-listed Three-striped Roof Turtle. • Apart, it also supports endangered Baer's pochard and near-threatened ferruginous duck. • **Area-2.40 sq. km.** • **Declaration-8.11.2005**

Site Name	State Location	About
Bakhira Wildlife Sanctuary	**Uttar Pradesh**	• It is the largest natural floodplain wetland in India. • It was established in 1980. • It provides a wintering and staging ground for a number of migratory waterfowls and a breeding ground for resident birds. • Migratory birds from Tibet, China, Europe & Siberia come here during the winter season. • There are more than 30 species of fish found in the lake. • However, the dominant species are Labeo rohita and Channa spp. • **Area-28.94 sq. km.** • **Declaration-29.06.2021**
Haiderpur Wetland	**Uttar Pradesh**	• It is a UNESCO Ramsar site, situated within the Hastinapur Wildlife Sanctuary. • It is one of the largest human-made wetlands that was formed in 1984 after the construction of the Madhya Ganga Barrage. • The region is fed by the Hanges and its tributary Solani River. • The wetland is home to over 320 species of birds, which includes many globally threatened species. • Among the mammals, leopards, Wildcats, Monkeys, foxes, wolves, Nilgai, Jackals, Mongoose, Honey badgers, Barasingha, Wild boars, and Rabbits are very common. • **Area-69.08 sq. km.** • **Declaration- 13.04.2021**
Nawabganj Bird Sanctuary	**Uttar Pradesh**	• In 2015, the name was changed to Shahid Chandra Shekhar Azad Bird Sanctuary. • It is a shallow marsh, that is primarily fed by monsoon rain, but also receives water from the Sarda Canal. • It provides protection to various species of migratory birds (Such as greylag goose, pintail, cotton teal, red-crested pochard, and gadwall) and local birds. • A small deer park has also been established in the sanctuary. • The highly invasive common water hyacinth poses a threat to its existence and dependent species. • **Area-2.25 sq. km.** • **Declaration-19.9.2019**
Parvati Arga Bird Sanctuary	**Uttar Pradesh**	• It is a permanent freshwater environment. • The two oxbow lakes, Parvati Tal and Arga Tal make up this ecosystem. • It provides protection to some of India's threatened vulture species, including the Indian vulture and the white-rumped vulture. • It is a roosting and breeding site for over 100000 birds annually. • The ancient temples around the lakes provide religious significance and encourage tourism. • **Area-7.22 sq. km.** • **Declaration-2.12.2019**
Saman Bird Sanctuary	**Uttar Pradesh**	• It is an oxbow lake in the Ganges floodplain. • It is a seasonal water body. • The sanctuary is an important bird area • Some important birds species here are- Sarus Cranes and Black Necked Storks as well as sharp hunters like the Egyptian vulture, Sparrow Hawk, Black Shouldered Kite, Crested Serpent Eagle, and Black Kite. • **Area-5.26 sq. km.** • **Declaration- 2.12.2019**

Site Name	State Location	About
Samaspur Bird Sanctuary	Uttar Pradesh	• It is situated in the Indo-Gangetic Plains and is a l perennial lowland marsh. • It supports more than 250 varieties of birds. • Example: greylag goose, pintail, common teal, Eurasian wigeon, northern shoveler, and ruddy shelduck. • **Area-7.99 sq. km.** • **Declaration-3.10.2019**
Sandi Bird Sanctuary	Uttar Pradesh	• It is a freshwater marsh. • It receives most of its water from monsoon rains. • It is home to over 1% of the South Asian populations of common teal, red-crested pochard, and ferruginous duck. • It is also known by its ancient name as "Dahar Jheel". • River Garra, formerly known as Garun Ganga, passes near the sanctuary. • It provides support to the migratory birds • **Area-3.09 sq. km.** • **Declaration-26.9.2019**
Sarsai Nawar Jheel	Uttar Pradesh	• The name of the site is inspired by the sizeable population of non-migratory Sarus Crane and it aims to protect its habitat. • Other threatened species present include the critically endangered white-rumped vulture and endangered woolly-necked stork. • The wetland is also a site of spiritual and religious significance with the nearby Hajari Mahadev temple • **Area-1.61 sq. km.** • **Declaration-19.9.2019**
Sur Sarovar	Uttar Pradesh	• It is also known as Keetham Lake. • It is located near Agra, next to the river Yamuna. • It is a resting home to more than 165 migratory and resident bird species. • Some important aquatic birds here are Little Grebes, Cormorants, Darter, Grey Heron, Night Heron, Common Teal, Indian Spot-Billed Duck, Shovelers, and Comb Duck. • **Area-4.31 sq. km.** • **Declaration-21.8.2020**
Upper Ganga River	Uttar Pradesh	• It is a shallow river stretch of the Great Ganges. • It provides habitat for IUCN Red listed Ganges River Dolphin, Gharial, Crocodile, 6 species of turtles, otters, 82 species of fish, and more than a hundred species of birds. • Major plant species, some of which have high medicinal values, include Dalbergia sissoo, Saraca indica, Eucalyptus globulus, Ficus bengalensis, and aquatic Eichhorina. • This river stretch has high religious importance among Hindus. • **Area-265.90 sq.km.** • **Declaration-8.11.2005**
Asan Conservation Reserve	Uttarakhand	• It is the first and only Ramsar site of Uttarakhand. • The reserve includes the Asan barrage, which was built across the Asan River to regulate water flow and generate hydroelectric power. • It is an important habitat for several species of birds including migratory birds, which makes it a tourist destination for birdwatching. • **Area-4.44 sq. km.** • **Declaration- 21.7.2020**

Site Name	State Location	About
East Kolkata Wetlands	West Bengal	- It is home to both natural and man-made wetlands. - It is located on the eastern side of Kolkata. - It includes salt marshes, agricultural fields, sewage farms, and settling ponds. - The significance of this site lies in that it is used to treat Kolkata's sewage, and the nutrients contained in the wastewater sustain fish farms and agriculture. - **Area-125.00 sq. km.** - **Declaration-19.8.2002**
Sunderbans Wetland	West Bengal	- It is the largest wetland site in India. - It is located in the deltas of the Ganga and the Brahmaputra rivers. - The Site is also home to a huge variety of rare and endangered species, including the fishing cat, northern river terrapin, and the Irrawaddy dolphin. - **Area-4230.00 sq. km.** - **Declaration:30.1.2019**



Ramsar Sites in India

13

COASTAL EROSION AND REGULATION

Coastal erosion refers to the long-term removal of sediment and rocks along the coastline. It is a natural process driven by various factors such as wave action, tides, currents, and wind-driven water. Over time, these forces can wear away the land and reshape the coastline. Coastal erosion can result in the loss of land, destruction of habitats, and other detrimental impacts on coastal ecosystems. Human activities, such as the construction of coastal structures, beach sand mining, and offshore dredging, can accelerate and intensify coastal erosion.

THE EXTENT OF COASTAL EROSION

In a recent study (2022) of the Ministry of Earth Sciences, the following observations have been made:

- Over the past 28 years, approximately 34% of the country's coastline has experienced varying degrees of erosion.
- Out of the total coastline studied, 26% is undergoing a process known as accretion, where sediment and land buildup occur naturally. This indicates a positive trend of land gain in these areas.
- Additionally, 40% of the coastline remains in a stable state, with no significant erosion or accretion observed
- Among the states analyzed, West Bengal has experienced the most severe erosion followed by the states of Kerala, Tamil Nadu, and Gujarat, which have also been significantly impacted by erosion.

REASONS FOR COASTAL EROSION

Coastal erosion can be attributed to various factors, both natural and human-induced. The following are some of the key reasons for coastal erosion:

- **Construction of coastal structures:** The construction of seawalls, breakwaters, and groynes disrupts natural sediment movement, leading to erosion in adjacent areas. These structures can also obstruct the buffering effect of sand dunes and vegetation, making the coastline more vulnerable to erosion.
- **Beach sand mining:** Excessive mining of sand from beaches for construction and industrial purposes depletes the natural sediment reservoir. This reduces the beach's ability to replenish itself, resulting in increased erosion and the loss of protective coastal features.
- **Offshore dredging:** Dredging activities, such as excavating sediment from the seabed for navigation or development purposes, disrupt the natural balance of sediment supply. This can alter erosion patterns and contribute to coastal erosion by depriving the coastline of the necessary sediment to maintain its stability.

IMPACTS OF COASTAL EROSION

Coastal erosion affects both the natural environment and human activities along coastlines. The erosion process is driven by natural forces and exacerbated by human activities.

- **Destruction of animal and plant habitats and aesthetic losses:** Coastal erosion results in the loss and degradation of important habitats such as beaches, dunes, salt marshes, and mangrove forests. These ecosystems provide homes and breeding grounds for a wide variety of plant and animal species. As erosion progresses, these habitats are destroyed, leading to biodiversity loss and ecological imbalances. Additionally, the erosion of scenic coastlines diminishes their aesthetic value, impacting tourism and recreational activities.
- **Economic impacts on fishing industries:** Coastal habitats, such as estuaries and shallow coastal waters, are vital for many commercial and subsistence fishing activities. Erosion affects these habitats, reducing fish populations and disrupting the livelihoods of fishing communities. As a result, the fishing industry suffers economic losses, including reduced catch yields, decreased income, and job losses.

- **Loss of fertile land:** Coastal areas often possess fertile soils that support agricultural activities. However, erosion can lead to the loss of this valuable land resource. As coastal soils are eroded, their fertility diminishes, making them unsuitable for cultivation. This loss of fertile land negatively impacts agricultural production, food security, and the livelihoods of coastal farming communities.
- **Damage to transport infrastructure and loss of tourism:** Coastal erosion undermines the stability of the land, leading to the degradation and damage of transport infrastructure such as roads, bridges, and coastal protection structures. Additionally, eroded coastlines can deter tourists, who are drawn to the beauty and recreational opportunities offered by coastal areas. The loss of tourism revenue affects local economies and employment in coastal regions.

INITIATIVES TAKEN

India has implemented various measures to combat coastal erosion, protect valuable coastlines, and mitigate the negative impacts on ecosystems and communities. Some of the important initiatives taken in India are:

- **Indian National Centre for Ocean Information Services (INCOIS):** It is an autonomous organization under the Ministry of Earth Sciences.
    - **Coastal Vulnerability Index:** INCOIS carries out Coastal Vulnerability Index (CVI) mapping to assess the implications of sea-level rise along the Indian coast. The CVI uses seven parameters viz. shoreline change rate, sea-level change rate, coastal elevation, coastal slope, coastal geomorphology, significant wave height and tidal range. It helps identify vulnerable areas and guides decision-making for coastal management and protection.
- **Integrated Coastal Zone Management Plan (ICZM):** The ICZM aims to ensure the optimum and sustainable use of coastal natural resources. It incorporates scientific knowledge, stakeholder participation, and regulatory frameworks to balance developmental activities with environmental protection.
- **National Centre for Sustainable Coastal Management (NCSCM):** The NCSCM conducts research in Coastal Zone Management (CZM), focusing on coastal resources and the environment. Through scientific studies and data-driven approaches, it contributes to the development of effective strategies and policies to mitigate coastal erosion.
- **Blue Flag Beach Program:** It is an eco-label (international certification) given to the cleanest beaches in the world. It recognizes beaches and marinas that meet specific criteria related to water quality, environmental management, safety, and services. Foundation for Environment Education in Denmark (FEE) accords the Blue Flag Cerification.

List of Blue Flag Beaches in India

As of 2022, there 12 Blue Flag Beaches in India

Beach	State
Shivrajpur	Gujarat
Ghoghla-Diu, Kasarkod and Padubidri	Karnataka
Kappad	Kerala
Golden	Odhisa
Kovalam	Tamil Nadu
Radhanagar	Andaman and Nicobar Islands
Eden	Puducherry
Minicoy Thundi and Kadmat	Lakshwadweep

Coastal Regulation Zones

It is a demarcated area along the coasts of India that is subject to stringent regulations and guidelines. The primary objective of CRZ regulations is to safeguard the coastal environment, its ecosystems, and the livelihoods of the coastal communities from the adverse impacts of developmental activities.

Coastal Regulation Zone Regulations 2019:

Background: Ministry of Environment, Forest and Climate Change constituted a committee in 2014 under the chairmanship of **Dr. Shailesh Nayak**, to review the existing challenges in the 2011 regulations and suggest a comprehensive, collaborated, and coordinated framework to protect the fragile environment of the coastal areas. The committee submitted its report in 2015 with several new provisions along the strict lines. Finally, after the consultation with coastal states and other stakeholders, the Union Cabinet gave its assent to the regulations in 2018 and Ministry announced new regulations in 2019.

Objectives: The primary objectives of the CRZ Regulations 2019 are:

- To protect the coastal environment, including its ecosystems and natural resources.

- To balance the need for sustainable development with the preservation of the coastal zone.
- To regulate activities that may harm the environment, such as construction and industrial activities.
- To safeguard the livelihoods of coastal communities, such as fishermen and farmers, by promoting their interests.
- To prevent and control pollution in the coastal zone.
- To encourage scientific research and monitoring of the coastal environment.
- To increase public awareness and participation in protecting and conserving the coastal environment.

Costal Regulation Zone Rules, 2011

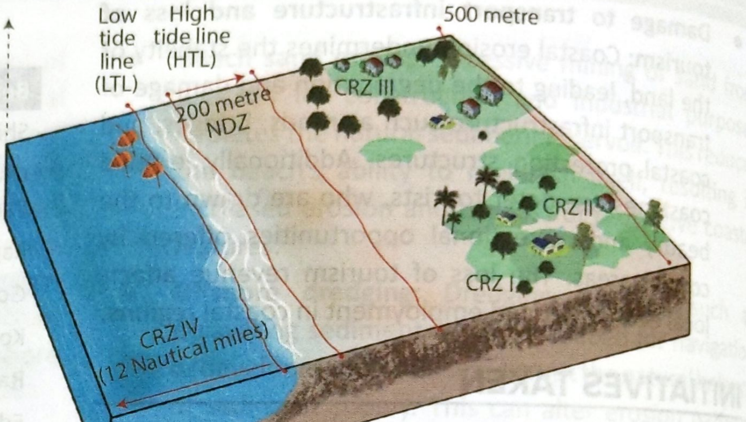
CRZ I: Eco-sensitive and intertidal areas

CRZ II: Areas which have been developed up to or close to the shore

CRZ III: Areas that are relatively undisturbed and do not fall under CRZ-I or CRZ-II

CRZ IV: Areas between Low Tide Line and 12 nautical miles into the sea/tidal influenced waterbodies

NDZ: No development zone that extends up to 200m from High Tide Line towards land in CRZ-III area



Costal Regulation Zone Rules, 2019

CRZ I A: Eco-sensitive areas

CRZ I B: Inter-tidal areas

CRZ II: Areas which have been developed up to or close to the shore

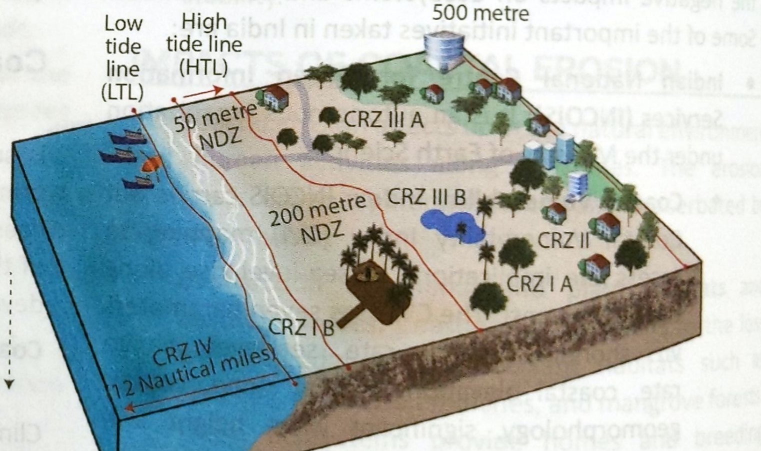
CRZ III A: CRZ-III areas, where the population density is more than 2,161sq km as per 2011Census

CRZ III B: Areas with population density of less than 2,161 per sq km, as per 2011 Census

CRZ IV A: 12 nautical miles from the Low Tide Line towards the sea

CRZ IV B: Tidal influenced waterbodies

NDZ: 50 metres from High Line in CRZ III A areas, 200 m from HTL in CRZ-III B areas



Costal Regulation zone Rules

Key Provisions:

Provision	Details
Expansion of the Coastal Zone	CRZ 2019 has expanded the coastal zone from the earlier 100 meters to 500 meters from the high tide line. This expanded limit will provide greater and additional protection to the sensitive coastal areas.
No Development Zone	The new rules have designated a No Development Zone (NDZ) of 20 meters, which is to be measured from the High Tide Line. No construction activity such as Roads and buildings is allowed in this zone, except construction important for the security of India and public safety, subject to appropriate permissions.

Provision	Details
CRZ Classification	2019 regulations have divided Coastal zones into four categories according to sensitivity, such as: • **CRZ-I or Ecologically Sensitive Areas:** These areas are of significant ecological importance, such as mangroves, coral reefs, breeding and spawning grounds of fish, and habitats of endangered species. • **CRZ-II or Urban Areas:** This category includes areas that are already developed or have existing infrastructure, such as municipal areas or other local authorities • **CRZ-III or Rural Areas**: This category comprises relatively underdeveloped areas with a population density of fewer than 2,161 persons per square kilometre. • **CRZ-IV or Water Area**: This category includes all water areas within the coastal zone.
Redefining Hazard Line	It is a line that separates the area which is more prone or vulnerable to natural disasters, such as floods, cyclones, sea level rise, etc from the other areas. The redefined Hazard line will be scientifically drawn according to factors like tidal waves, sea level rise, shoreline changes, and other natural phenomena.
Tourism Activities	Though the tourist activities such as shacks and water sports are allowed in the coastal zones, but they are subject to stringent regulations and require certain prior permissions.
Coastal Zone Management Plans (CZMP)	The 2019 regulations mandate the preparation of CZMP for each coastal state and union territory. They will act as the blueprint for all the regulations and are required to be reviewed every five years.

Activities Restricted and Allowed:

CRZ-I or Ecologically Sensitive Areas: The following activities are restricted within CRZ-I:

- All construction activities are prohibited, except for projects related to the Department of Atomic Energy, the Ministry of Defence, and other strategic projects, subject to clearance from the Ministry of Environment, Forest, and Climate Change.
- Setting up of any new industry or expansion of existing industries is prohibited, except for those related to fish processing, seaweed cultivation, and desalination plants, subject to clearance from the Ministry of Environment, Forest, and Climate Change.
- Mining, reclamation, and bunding of the coastal zone are prohibited.
- All forms of tourism activities, except ecotourism, are prohibited.

Certain regulated activities are allowed in CRZ-I, subject to certain conditions:

- Traditional fishing activities are allowed, subject to regulations prescribed by the concerned authorities.
- Repair of traditional structures, such as fishing boats, is allowed.
- Scientific research and monitoring activities are allowed, subject to necessary clearances.

CRZ-II or Urban Areas: The following activities are regulated within CRZ-II:

- New constructions are allowed subject to necessary clearances and as per the provisions of the local Coastal Zone Management Plan (CZMP).
- The expansion of existing industries is allowed subject to necessary clearances and compliance with pollution norms.
- Tourism activities are allowed, subject to regulations prescribed by the concerned authorities.

Certain regulated activities are prohibited in CRZ-II:

- Setting up of new industries, except for those related to fish processing, seaweed cultivation, and desalination plants, subject to clearance from the Ministry of Environment, Forest, and Climate Change.
- Mining, reclamation, and bunding of the coastal zone are prohibited.

CRZ-III or Rural Areas: The following activities are regulated within CRZ-III:

- New constructions are allowed subject to necessary clearances and as per the provisions of the local Coastal Zone Management Plan (CZMP).
- Expansion of existing industries is allowed, subject to necessary clearances and compliance with pollution norms.
- Tourism activities are allowed, subject to regulations prescribed by the concerned authorities.

Certain regulated activities are prohibited in CRZ-III:

- Setting up of new industries, except for those related to fish processing, seaweed cultivation, and desalination plants, subject to clearance from the Ministry of Environment, Forest, and Climate Change.
- Mining, reclamation, and bunding of the coastal zone are prohibited.

CRZ-IV or Water Area:

The following activities are regulated within CRZ-IV:

- Fishing and other traditional activities are allowed, subject to regulations prescribed by the concerned authorities.
- Setting up of fish farms and hatcheries is allowed, subject to necessary clearances and compliance with pollution norms.

Certain regulated activities are prohibited in CRZ-IV:

- Similar to CRZ-III and according to local Coastal Zone Management Plans.
- conducting research related to marine fisheries and the sustainable use of marine resources.

Institutions Involved in Coastal Zone Management

- **National Coastal Zone Management Authority (NCZMA):** It is the apex body at the National level, that is responsible for coordinating and monitoring the implementation of the CRZ notifications and approving the CZMPs submitted by the Coastal States and Union Territories.
- **Coastal Zone Management Authorities (CZMA):** CZMAs are responsible for the implementation and enforcement of CRZ regulations at the state and union territory levels. They are also responsible for preparing the CZMPs.
- **District Level Committees (DLC):** DLCs are established at the district level to monitor the implementation of the CRZ regulations and to assist the CZMAs in preparing the CZMPs.
- **State Pollution Control Boards (SPCB):** SPCBs are responsible for monitoring and regulating pollution from industries and other sources in the coastal zone.
- **State and Union Territory Departments of Forests and Wildlife:** These departments are responsible for the conservation and management of the forests and wildlife in the coastal zone.
- **National Institute of Oceanography (NIO):** NIO is responsible for conducting research and surveys related to the coastal zone environment.
- **Central Marine Fisheries Research Institute (CMFRI):** CMFRI is responsible for

DEFORESTATION

Deforestation refers to the deliberate and permanent removal of forests and woodlands, through clear-cutting or burning, without replanting or allowing for natural regeneration. The UN Food and Agricultural Organization (FAO) has defined deforestation as "the conversion of forest to another land use or the long-term reduction of tree canopy cover below the 10% threshold."

STATUS OF FORESTS

According to the Global Forest Resources Assessment (FRA) 2020,

Parameter	Global Perspective	India Perspective
Forest area	The total forest area in the world is approximately 4.06 billion hectares, with approximately two-thirds of the world's forests located in developing countries.	India's forest area increased by 4.7 million hectares between 2015 and 2020, reaching 751 million hectares. India's forest cover as a percentage of total land area increased from 21.67% in 2015 to 21.92% in 2020.
Biodiversity	Forests are important for the conservation of biodiversity, with approximately 80% of the world's terrestrial species relying on forests for their habitat.	India has a high level of biodiversity, with over 15,000 species of higher plants and 91,000 species of animals.
Deforestation	Forest fires and Deforestation continues to be a major issue, with an estimated 10 million hectares of forest being lost each year. The majority of deforestation is taking place in the tropics, particularly in South America and Africa.	India's deforestation rate was 0.20% per year between 2010 and 2020, which is lower than the average rate for developing countries (0.33%)

The Global Forest Resources Assessment (FRA) 2020 Report

It is a comprehensive assessment of the world's forests, conducted by the Food and Agriculture Organization (FAO) of the United Nations every five years since 1990.

FACTORS RESPONSIBLE FOR DEFORESTATION

Deforestation is caused by a complex interplay of social, economic, and environmental factors.

Direct factors responsible for deforestation

- **Agricultural expansion:** According to Food and Agriculture Organisation (FAO), agricultural expansion drives almost 90% of global deforestation.
  - **Agriculture:** Subsistence farming, commercial agriculture, shifting cultivation cause deforestation. In India, Britishers had converted huge tracts of forests, particularly on hill slopes into tea and coffee plantations.
  - **Grazing:** Excessive grazing by livestock, especially in areas with inadequate management and monitoring, lead to the degradation and loss of vegetation cover. According to FAO, grazing accounts for 40% of deforestation. In India, overgrazing and encroachment of grassland for agricultural activities are the causes for land degradation in Gujarat.
  - **Expansion of pasturelands**: The expansion of pasturelands to accommodate growing livestock populations often requires clearing forested areas. Forests are cleared to create space for grazing and to establish new pasturelands, resulting in deforestation.

- **Monoculture:** The practice of monoculture has led to destruction of forests. This practice also leads to soil degradation and biodiversity loss.

- **Logging:** The demand for timber and other forest products drives the extraction and removal of trees from forested areas.
  - **Unsustainable harvesting:** The high demand for wood products has led to the unsustainable harvesting of trees, which result in the depletion of forest resources and loss of biodiversity.
  - **Illegal logging:** Illegal logging, carried out without proper authorization or in violation of forestry regulations, is a significant contributor to deforestation. It is often associated with corruption, organized crime, and the illegal trade of timber.
  - **Clear-cutting:** It is a logging method that involves the complete removal of trees in an area. It has devastating effects on ecosystems, including soil erosion, habitat loss, and reduced water quality.
  - **Collateral damage:** Logging operations cause collateral damage to surrounding areas beyond the designated logging sites. The extraction of timber may result in the destruction of adjacent forests, impacting biodiversity, water resources, and ecosystems.

- **Infrastructure development**: Construction of roads, dams, and other infrastructure projects often results in the clearance of large areas of forest.
  - **Roads and Highways:** The construction of roads and highways requires the clearing of large areas of forests, which lead to habitat destruction and fragmentation, making it harder for wildlife to move between different areas.
  - **Dam construction**: The construction of dams and reservoirs for hydroelectric power generation or irrigation purposes often involves flooding large areas of forested land. This leads to the loss of valuable forest ecosystems and habitats.
  - **Industrial development**: The establishment of industrial facilities, factories, and manufacturing plants often necessitates the clearing of forested areas for construction and operation.

- **Urbanization:** The growth of cities and the expansion of urban areas into nearby forests also contributes to deforestation.
  - **Growth of cities:** The growth of cities and towns requires clearing land for infrastructure, housing, and commercial development.
  - **Increased demand for agricultural land:** The expansion of urban areas leads to increased demand for agricultural land, further increasing deforestation.
  - **Population growth and housing demands:** Rapid urbanization is driven by population growth and the increasing demand for housing. Cities expand to accommodate the growing population, forests and green spaces are often converted into residential areas, leading to deforestation.
  - **Industrial and commercial development:** Urbanization is closely linked to industrial and commercial growth. Forested areas may be cleared to establish factories, manufacturing plants, shopping malls, and other commercial establishments, contributing to deforestation.

- **Fire**: Wildfires can be both natural and human-caused fires that destroy large areas of forest and contribute to deforestation.
  - **Natural wildfires:** In savannas or grasslands, the forests are destroyed if the fires spread uncontrollably. Climate change also increase the frequency and intensity of fires, making deforestation more likely.
  - **Damage to forest ecosystem:** Fires cause long-term damage to the ecosystem by altering the soil and vegetation, making it difficult for forests to regrow. This leads to a loss of biodiversity and ecosystem services that the forest provides.

- **Demand for firewood:** Firewood is widely used as a source of fuel in many parts of the world, particularly in developing countries. The demand for firewood has led to the overexploitation of forests, with people cutting down trees faster than they regrow.

- **Mining:** Mining operations often require large areas of land to be cleared for infrastructure, such as roads, railways, and mining facilities, which contribute to deforestation. Mining operations often involve the use of toxic chemicals, such as mercury and cyanide, for mineral extraction. Accidental spills or improper waste management result in the contamination of soil, water sources, and nearby forests.

Case study: Amazon deforestation

According to a study by the Amazon Network of Georeferenced Socio-Environmental Information and MapBiomas, the Amazon region has experienced a decline in its native vegetation, accounting to 10% over a period of 40 years. The lost forest area is primarily tropical rainforest, which covers an area roughly equivalent to the size of the state of Texas.

About Amazon Forest

The Amazon Forest is the world's largest tropical rainforest and is located in South America along the Amazon River. It ranges across nine countries, including Brazil, Bolivia, Ecuador, Venezuela, Peru, Colombia, Guyana, Suriname, and French Guiana.

Significance of the Amazon Forest

- **Rich biodiversity:** Amazon is home to almost 20% of all land species on the planet
- **Climate regulation:** Transpiration from the Amazon rainforest contributes to the production of 50 to 75 percent of the world's precipitation. The moisture from the rainforest also influences rainfall patterns in Central America and the Western United States.
- **Carbon sink:** The Amazon rainforest, sequesters massive amounts of carbon. It stores over 120 billion metric tonnes of carbon (equivalent to 12 years of global emission at current rates), which is more than one-third of the carbon stored by tropical forests across the globe.

Drivers of the deforestation

- **Cattle ranching:** The Amazon Rainforest experiences deforestation, largely due to the high demand for cattle meat consumption. Brazil is a major exporter of cattle meat.
- **Slash and burning:** To create space for crops and cattle grazing fields, small-scale agriculture requires cutting down and burning sections of the forest.
- **Forest fires:** Though Amazon rainforests are dense and the chances of forest fires are negligible, rapid deforestation have accentuated the chances of forest fires.
- **Mining:** Rapid deforestation takes place for extracting valuable minerals such as gold.
- **Industries and infrastructure building:** Infrastructure development projects like road and dam constructions in the forest, funded by the government, indirectly contribute to deforestation.

Consequences to be faced with disappearance of the Amazon forests

- **Destruction of world species:** 30% of all species may disappear.
- **Dry weather and floods:** Shift in climate change, longer aridity, massive floods will be a frequent recurrence.
- **Threat to agriculture, water and food supplies:** Deforestation of the Amazon rainforest may cause warmer temperatures, frequent floods, long droughts, increased pests and infections, and reduced water resources for crops.

Initiatives to combat deforestation

- The LEAF coalition: It aims to protect tropical forests by mobilizing $1 billion in financing to countries committed to this cause. It is one of the most significant public-private efforts undertaken for this purpose.

Indirect factors responsible for deforestation

- **Weak governance and law enforcement**: Inadequate enforcement of forest protection laws, corruption, and weak governance systems contribute to deforestation. Illegal logging and land encroachment often go unchecked, allowing deforestation to persist.
- ***Lack of awareness and education***: Limited understanding of the environmental importance of forests and unsustainable land use practices lead to deforestation.
- **Global demand for commodities**: International demand for commodities like soy, palm oil, beef, and cocoa fuels deforestation in tropical regions. These commodities are often linked to deforestation through indirect supply chains and international trade.
- **Land tenure issues and land conflicts**: Unclear land tenure rights and disputes over land ownership often leads to deforestation. Lack of secure land rights incentivize illegal land grabbing and forest clearance by individuals and corporations.
- **Migration**: Certain factors related to migration contribute to deforestation:
  - **Population pressure**: Migration to regions with available land and resources lead to increased population density, resulting in agricultural expansion and forest clearing to meet the needs of growing settlements.
  - **Shifting cultivation**: Migrants practicing shifting cultivation clear land by burning forests for

short-term agriculture before moving to new areas. Over time, this practice contributes to deforestation as migrants settle in different regions.

- **Lack of alternative livelihoods**: Limited economic opportunities in migrants' places of origin drive them to forested areas. Without viable alternatives, they may resort to unsustainable practices like illegal logging, poaching, or encroachment, contributing to deforestation.
- Poverty: In many parts of the world, poor communities engage in subsistence agriculture and slash-and-burn practices, leading to the clearance of forested areas for agriculture.
- **Poverty and lack of alternative livelihoods**: Poverty and limited economic opportunities drive communities to rely on forest resources for their survival. Subsistence activities like fuelwood collection, illegal logging, and slash-and-burn agriculture become the only means of income for some communities.

- **Climate change**: It indirectly contributes to deforestation through various mechanisms:
  - **Increased frequency and severity of wildfires:** Climate change leads to drier conditions and higher temperatures, increasing the risk of wildfires. These fires result in the destruction of forests and contribute to deforestation.
  - **Changes in precipitation patterns:** Climate change alter rainfall patterns, causing shifts in the distribution and intensity of rainfall. This affects the availability of water resources for forests, impacting their health and increasing their susceptibility to diseases and pests.
  - **Droughts and water scarcity:** Climate change leads to more frequent and severe droughts, which stress forests and make them more vulnerable to insect infestations, diseases, and wildfires. Droughts also reduce water availability for forest ecosystems, leading to forest degradation and potentially deforestation.
  - **Increased pest outbreaks:** Warmer temperatures and altered climate conditions favor the proliferation of pests and insects that attack forests. Outbreaks of pests such as bark beetles result in widespread tree mortality. This may lead to deforestation if left uncontrolled.
  - **Feedback loops:** Deforestation itself contributes to climate change by releasing stored carbon dioxide into the atmosphere. As climate change worsens, it creates feedback loops that further exacerbate deforestation. For example, warmer temperatures increase the incidence of forest fires, which in turn contribute to deforestation and release more carbon dioxide.

Consequences of Deforestation

- **Biodiversity loss:** Deforestation causes biodiversity loss in the following ways:
  - **Habitat Loss:** Deforestation destroys natural habitats, impacting biodiversity. For example, reduced forest cover has affected wildlife habitats of tigers and elephants in the mineral belts of Jharkhand.
  - **Species Extinction:** Forest destruction disrupts ecosystems, leading to the extinction of species reliant on forests.
  - **Fragmentation:** Deforestation divides forests into smaller patches, restricting species movement and increasing extinction risk.
  - **Disruption of Ecological Relationships:** Deforestation disturbs vital interactions like pollination and seed dispersal.
  - **Loss of Keystone Species:** Deforestation eliminate key species, causing ripple effects throughout the ecosystem.
  - **Decline in Biodiversity Hotspots:** Forest loss in biodiverse areas reduces unique species and global biodiversity.
  - **Climate Change Impacts:** Deforestation releases stored carbon, exacerbating climate change and indirectly affecting biodiversity.
  - **Loss of Medicinal Resources:** Deforestation reduces access to valuable medicinal plants and limits traditional medicine practices.
  - **Ecological Imbalance:** Deforestation disrupts ecosystem balance, leading to invasive species and altered ecological dynamics.
- **Soil degradation:** Deforestation causes soil degradation, in the following ways:
  - **Loss of Organic Matter**: Forest clearance prevents the addition of organic matter to the soil, reducing nutrient content and organic carbon levels.

  - **Soil Erosion**: Without tree roots to bind the soil, erosion caused by wind and water becomes more prevalent, leading to the loss of topsoil and valuable nutrients.
  - **Nutrient Depletion**: Deforestation disrupts the nutrient cycling system of forests, resulting in the loss of stored nutrients and leaching of essential elements from the exposed soil.
  - **Increased Soil Temperature**: Removal of tree cover exposes the soil to direct sunlight, leading to higher temperatures that accelerate organic matter decomposition and affect nutrient availability.
  - **Changes in Soil Moisture**: Deforestation disrupts the natural water-holding capacity of forests, altering soil moisture levels and impacting microbial activity and nutrient availability.
  - **Soil Compaction**: Clearing forests leads to soil compaction and decreased soil health.
- **Water cycle disruption:** Deforestation disrupts water resources, affecting aquatic organisms reliant on forest habitats. It also poses risks to water security, including reduced agricultural productivity and access to clean drinking water. The impacts of deforestation on the hydrological cycle is as follows:
  - **Reduced evapotranspiration**: Deforestation decreases water vapor release by trees, affecting moisture levels and precipitation patterns.
  - **Increased runoff**: Deforested areas experience higher surface runoff, causing soil erosion, floods, and reduced groundwater recharge.
  - **Soil moisture depletion**: Deforestation reduces soil's ability to retain moisture, resulting in drier soil conditions.
  - **Altered streamflow**: Deforestation disrupts natural stream and river flow, leading to water shortages and limited availability.
  - **Increased sedimentation**: Deforestation contributes to sediment buildup in water bodies, negatively impacting aquatic ecosystems and water quality.
  - **Reduced water infiltration**: Deforestation reduces water absorption into the soil, resulting in decreased groundwater recharge.
  - **Impacts on water-dependent species**: Deforestation disrupts water resources, affecting aquatic organisms reliant on forest habitats.
  - **Human water security**: Deforestation poses risks to water security, including reduced agricultural productivity and access to clean drinking water.
- **Socio-Economic Impact**
  - **Disrupted traditional livelihoods:** Deforestation disrupts practices reliant on forest resources like hunting, gathering, and subsistence agriculture.
  - **Income and job loss:** Forest-based industries, such as timber and non-timber product collection, suffer from reduced opportunities and income due to deforestation.
  - **Food insecurity:** Access to forest resources like fruits, nuts, decreases, impacting food availability. Soil degradation as a result of deforestation also affects agricultural productivity.
  - **Increased poverty vulnerability:** Forest-dependent communities face poverty when their primary income source is lost without viable alternatives.
  - **Migration and displacement:** Deforestation-induced livelihood loss drives communities to migrate or be displaced.
  - **Cultural and social impacts:** Forest loss erodes cultural practices and traditional knowledge tied to forest-based livelihoods, affecting cultural heritage and community cohesion.
  - **Conflict and unrest:** Depletion of resources due to deforestation lead to conflicts over remaining resources, escalating tensions within affected communities.
  - **Unsustainable alternatives:** Without forest resources, communities may resort to unsustainable practices like illegal logging or encroachment on protected areas, exacerbating environmental degradation.
- **Increased natural disasters:** Deforestation accentuates natural disasters in the following ways:
  - **Altered hydrological cycles**: Deforestation disrupts water flow, affecting rainfall patterns and water availability, potentially increasing the frequency and intensity of natural disasters.
  - **Soil erosion and landslides**: Without tree roots to stabilize the soil, deforested areas are more susceptible to erosion and landslides, especially during heavy rainfall. For example, landslides and flash floods, particularly in hilly regions of India such as the Western Ghats.

  - **Flooding**: Deforestation reduces the natural buffering capacity of forests, causing rainwater to runoff faster and increasing the risk of downstream flooding.
  - **Increased vulnerability to droughts**: Deforestation reduces the ecosystem's ability to store and regulate water, making regions more vulnerable to droughts and water scarcity.
  - **Enhanced heat island effect**: Deforestation leads to higher surface temperatures, contributing to the formation of urban heat islands and exacerbating heatwaves.
  - **Loss of coastal protection**: Deforestation along coastlines removes natural coastal vegetation that provides protection against storm surges and erosion, making coastal communities more vulnerable to disasters like hurricanes and tsunamis.
  - **Reduced carbon sequestration**: Deforestation releases stored carbon into the atmosphere, contributing to greenhouse gas emissions and climate change, which influence the frequency and severity of natural disasters.

- **Climate change:** The impact of deforestation on climate change is as follows:
  - **Reduced carbon sequestration**: Forests act as carbon sinks, absorbing CO2 from the atmosphere through photosynthesis and storing it in trees and soil. Deforestation decreases the capacity to sequester carbon, leading to higher CO2 levels in the atmosphere.
  - **Altered climate patterns**: Forests play a crucial role in regulating local and regional climate conditions by influencing temperature, humidity, and precipitation. Deforestation disrupts these patterns, leading to changes in weather patterns and potentially contributing to more extreme climate events.
  - **Increased vulnerability to climate impacts**: Deforestation reduces the natural resilience of ecosystems and communities to climate change impacts such as droughts, floods, and heatwaves.

FOREST CONSERVATION MEASURES

Forest conservation refers to the practice of protecting and preserving natural forests and woodlands from destruction or degradation. It involves the sustainable management of forest resources to maintain their ecological, economic, and social values for present and future generations. Conservation efforts include measures such as protection forestry, production forestry, reforestation, afforestation, social forestry, community forestry, agroforestry, silviculture, etc.

Measure	Description	Examples
Protection Forestry	It is the practice of conserving forests through various measures such as fire prevention, pest management, and other protective measures including reserve and protected forests, establishment of protected areas such national parks and wildlife sanctuaries.	Various national parks in India such as Jim Corbett National Park, Bandipur National Park.
Production Forestry	It focuses on harvesting timber and other forest products in a sustainable and efficient manner; for example, by selective cutting.	Teak plantations in Maharashtra and Karnataka, bamboo plantations in Tripura, and eucalyptus plantations in Tamil Nadu
Reforestation	It is the process of planting trees in areas that were previously subjected to deforestation.	Himachal Pradesh Reforestation Project which is reforesting 4,000 hectares of the Siwalik hills in the state
Afforestation	It involves planting new trees or allowing natural regeneration to occur in an area where there has been a loss of forest cover due to deforestation, fire, or other causes.	National Afforestation Programme
Social Forestry	It involves management of forests on community lands for the purpose of meeting the social, economic, and environmental needs of local communities	Nagar Van Yojana, School Nursery Yojana.
Community Forestry	It is a participatory approach to forest management. It involves local communities in the planning, implementation, and monitoring of forest management activities	Van Panchayat system in Uttarakhand

Measure	Description	Examples
Agroforestry	It involves the integration of trees or shrubs with agricultural crops or livestock. It helps in improving crop productivity, soil quality, and provide additional sources of income to farmers.	Traditional practice of planting trees like neem, mango, or coconut alongside agricultural crops
Urban Forestry	It is the practice of planting and managing trees and other green spaces within urban areas. It helps in mitigating the effects of urban heat island, stormwater management, improves air quality and also enhances biodiversity in urban areas.	Development of city parks and gardens, such as Cubbon Park in Bengaluru, Lodhi Gardens in Delhi
Extension Forestry	It involves planting of trees on the sides of roads, canals and railways, wastelands.	PWD in Delhi planting trees along roads
Silviculture	It is the scientific management of cultivation and management of forests to ensure their long-term health, productivity, and sustainability. It involves a variety of techniques such as planting, pruning, thinning etc.	Joint Forest Management Programme

DO YOU KNOW?

The Bishnoi Movement was initiated around 290 years ago, during the early 18th century, in Rajasthan by the Bishnoi community. Led by a woman named **Amrita Devi**, a large number of Bishnois from 84 villages protested to preserve the Khejri trees that were ordered to be cut down under the orders of the Maharaja (King) of Jodhpur.

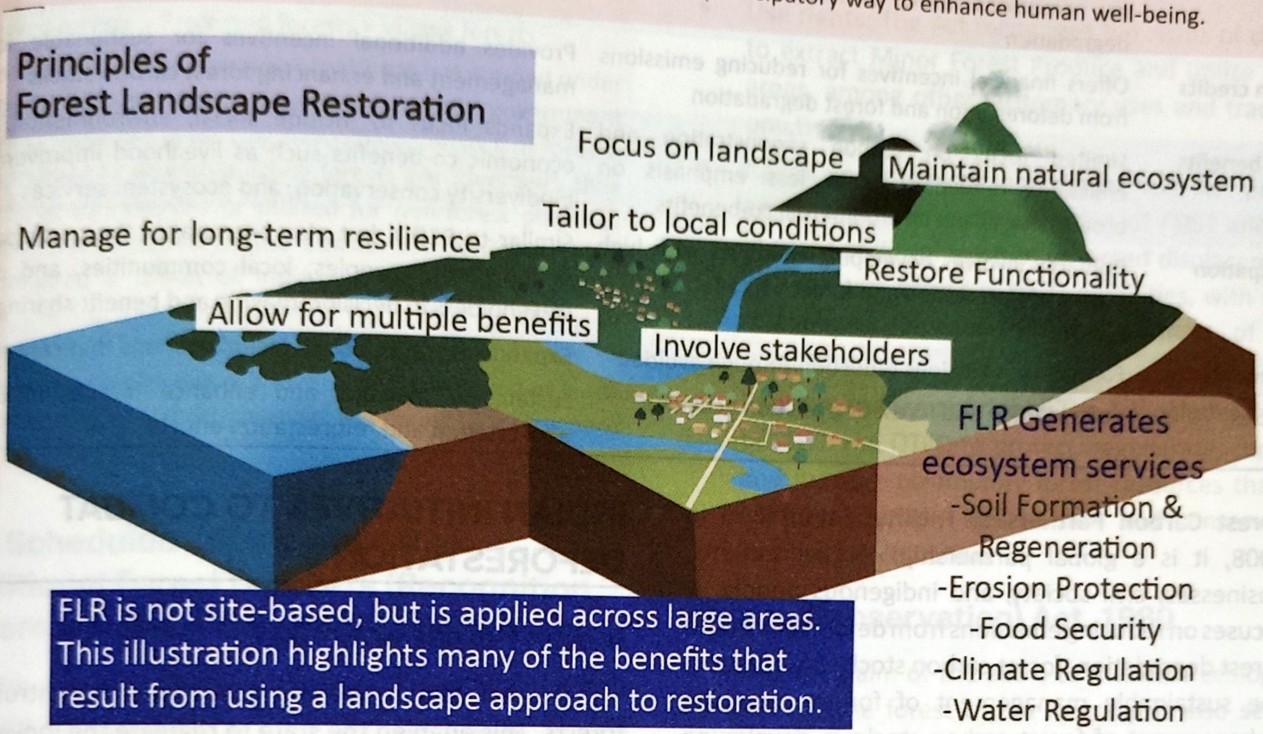
GLOBAL INITIATIVES TO COMBAT DEFORESTATION

- **Global Partnership on Forest and Landscape Restoration (GPFLR)**

  It was established in 2003 by IUCN, WWF, and the Forestry Commission of Great Britain. It is a proactive network that unites governments, organizations, communities, and individuals with a common goal of mobilizing support for forest and landscape restoration, assessing restoration potential, and fostering knowledge and networks in this field.
    - **GPFLR and India:** During the 2015 UNFCC Conference of the Parties (COP) held in Paris, India made a significant commitment by voluntarily joining the **Bonn Challenge.** Under this pledge, India aims to restore 13 million hectares of degraded and deforested land by 2020, followed by an additional 8 million hectares by 2030. This commitment from India is among the most substantial in Asia.
- ***United Nations Strategic Plan for Forests 2017-2030:*** It was approved during a special session of the UN Forum on Forests in 2017.
    - The plan comprises six Global Forest Goals and 26 related targets to achieve by 2030.
    - These goals and targets are voluntary and applicable worldwide.
    - An important target is to expand the global forest area by 3% by 2030.
- **Sustainable Development Goal- 15 (SDG-15, Life on Land):** The goal is to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
- **New York Declaration on Forests:** Launched at the UN Secretary-General's Climate Summit in September 2014, the New York Declaration on Forests (NYDF) outlines ten ambitious global targets to protect and restore forests and end natural forest loss by 2030. It is a voluntary and non-binding international declaration. It combines goals expressed in the context of a number of individual pledges and agreements, including the Paris Agreement, the Sustainable Development Goals, the Bonn Challenge, the 2020 Strategic Plan on Biodiversity, climate and forest financing pledges, and supply chain commitments. India has not signed the NYDF.
- **Glasgow Leaders' Declaration on Forests and Land Use:** At COP 26 of UNFCC, 137 countries committed to collectively end forest loss and land degradation by 2030.

Forest landscape restoration (FLR): It is a planned process that involves strategic intervention and active management of forests, aiming to restore their ecological, social, and economic values.

It encompasses a wide range of activities, including tree planting, natural regeneration, sustainable forest management, and the implementation of conservation practices. It restores landscape in a participatory way to enhance human well-being.


Principles of
Forest Landscape Restoration
Focus on landscape
Maintain natural ecosystem
Manage for long-term resilience
Tailor to local conditions
Restore Functionality
Allow for multiple benefits
Involve stakeholders
FLR Generates
ecosystem services
-Soil Formation &
Regeneration
-Erosion Protection
-Food Security
-Climate Regulation
-Water Regulation
-Rainfall
-Energy Security
-Disaster Risk Reduction
FLR is not site-based, but is applied across large areas.
This illustration highlights many of the benefits that
result from using a landscape approach to restoration.

Principles of Forest Landscape Restoration

- **REDD and REDD+**
  - **REDD**
    - **Background:** Reducing Emissions from Deforestation and Forest Degradation, or **REDD**, is a global project launched by the United Nations Framework Convention on Climate Change in 2005. The idea of REDD was put forward by Coalition of Rainforest States during the UNFCCC's Montreal Conference of Parties (CoP11) in 2005.
    - **Goal:** The goal of REDD was to mitigate climate change by reducing net greenhouse gas emissions from forests through better management. The initiative was primarily aimed towards underdeveloped countries.
  - **REDD+**
    - **Background:** The REDD+ project was accepted in the Bali Action Plan at CoP-13 in 2007. REDD+ is an expansion of REDD in that it extends the scope of REDD beyond mere forest protection.
    - **Goal:** It seeks to encourage developing nations to reduce greenhouse gas emissions (GHG) by slowing or stopping forest loss and increasing GHG removal from the atmosphere through forest management and extension.

Difference between REDD and REDD+

Basis	REDD (Reducing Emissions from Deforestation and Forest Degradation)	REDD+ (Reducing Emissions from Deforestation and Forest Degradation) +
Focus	Addressing deforestation and forest degradation	Expands the focus to include conservation, sustainable forest management, and enhancement of forest carbon stock

Basis	REDD (Reducing Emissions from Deforestation and Forest Degradation)	REDD+ (Reducing Emissions from Deforestation and Forest Degradation) +
Objective	Mitigating climate change by reducing greenhouse gas emissions from deforestation and forest degradation	Same as REDD, plus promoting sustainable forest management practices and biodiversity conservation
Carbon credits	Offers financial incentives for reducing emissions from deforestation and forest degradation	Provides additional incentives for sustainable forest management and enhancing forest carbon stocks
Social benefits	Limited focus on carbon sequestration and emissions reductions, with less emphasis on broader social and environmental co-benefits	Expands focus to include social, environmental, and economic co-benefits such as livelihood improvement, biodiversity conservation, and ecosystem services
Participation	Primarily involves developing countries with high rates of deforestation and forest degradation	Similar to REDD, but also encourages the participation of indigenous peoples, local communities, and other stakeholders in decision-making and benefit-sharing
Implementation Activities	Focuses on emissions reduction through avoided deforestation and forest degradation activities	Expands the approach to include actions that conserve, sustainably manage, and enhance forests, including afforestation and reforestation efforts

- **Forest Carbon Partnership Facility**: Established in 2008, it is a global partnership of governments, businesses, civil society, and indigenous people. It focuses on reducing emissions from deforestation and forest degradation, forest carbon stock conservation, the sustainable management of forests, and the enhancement of forest carbon stocks in developing countries (activities commonly referred to as REDD+). The World Bank takes on the responsibilities of a trustee and secretariat. It has two kinds of funds:
    - **Readiness Fund:** It helps countries prepare for REDD+ by developing the necessary policies and system
    - **Carbon Fund:** It provides payments for verified emission reductions from REDD+ programs in countries that have made considerable progress towards REDD+ readiness.
- **China-Africa Forest Cooperation**: It is a bilateral initiative (launched in 2013) between China and African countries aimed at promoting sustainable forest management and combating deforestation in Africa.

Miyawaki Method

The Miyawaki Method, pioneered by Japanese botanist Akira Miyawaki, is a form of urban forestry. It aims at revitalizing degraded urban areas and strengthening their resilience against climate change effects. This method involves densely planting a diverse selection of native tree species in small plots, facilitating rapid and natural forest growth. The resulting forests are characterized by high levels of biodiversity, improved air and water quality, and increased carbon sequestration.

INDIAN INITIATIVES TO COMBAT DEFORESTATION

Indian Forest Act, 1927

The Act established the government's control over forests. This enabled the state to regulate the movement of forest produce, prevent illegal felling of trees, and punish offenders. It also empowered the government to declare any area as a Reserved Forest, Protected Forest, or Village Forest, providing legal protection to forests and their resources.

The provisions of the Act were strengthened through subsequent amendments, which introduced penalties for unauthorized tree cutting and implemented more stringent regulations on the trade of forest produce. The 2012 amendment to the Act prohibited fresh clearances in forests and setting fire in a reserved forest.

Types of forests

Reserved forests: These forests are the most strictly regulated forest areas established by the State Government on forest land or government-owned wasteland. Local communities are generally prohibited from accessing reserved forests, unless granted specific permission by a Forest Officer during settlement procedures.

Protected forest: The State Government possesses the authority to designate non-reserved forest land as protected forests, giving the government ownership rights and the ability to impose regulations on their utilization. This provision has been utilized to assert governmental control over trees that possess economic value, such as those with revenue-generating potential through timber, fruit, or other non-wood products.

Village forest: Village forests are designated areas where the State Government can grant a village community the rights previously held by the government over land that has been designated as a reserved forest.

Degree of protection

Reserved forests > Protected forests > Village forests

Deemed forest: These are areas that have not notified under the legislation, but are recorded as forests in government records. These are lands that have characteristics of forests, irrespective of ownership. Once forests are "deemed", they cannot be de-reserved or utilized for non-forest purposes without prior approval of the Centre. in T N Godavarman Thirumulpad v. Union of India and Others (Godavarman case), the Supreme court ordered the setting up of expert committees in each state to identify deemed forests to remove any ambiguities with respect to the scope of lands that may receive protection under the Forest (Conservation) Act.

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

The Act recognizes the rights of traditional forest dwellers. It empowers them to participate in the sustainable management of forest resources and to protect forests from deforestation caused by activities such as logging, mining, and encroachment. The Act identifies four types of rights:

- **Title rights:** The Act grants Forest Dwelling Scheduled Tribes (FDST) and Other Traditional Forest Dwellers (OTFD) the right to ownership of land they cultivate, up to a maximum of 4 hectares. Ownership is limited to the land currently under cultivation by the respective family, without provision for new land grants.
- **Use rights:** The Act recognizes the rights of dwellers to extract Minor Forest Produce and utilize grazing areas, among other customary uses and traditional practices.
- **Relief and development rights**: The Act provides provisions for the rehabilitation of FDST and OTFD in cases of illegal eviction or forced displacement. It also ensures access to basic amenities, with certain restrictions imposed for the purpose of forest protection.
- **Forest management rights**: The Act includes the right of FDST and OTFD to protect, regenerate, conserve, and manage community forest resources that they have traditionally safeguarded and conserved for sustainable utilization.

Forest (Conservation) Act, 1980

The main aim of the act is to maintain ecology and to preserve the forest of our country. It also seeks to regenerate the forests by planting trees and increase the forest growth in our country.

Forest Conservation Rules, 2022

They have been notified under Forest (Conservation) Act, 1980. The Rules replace the Forest (Conservation) Rules, 2003.

Key Features of Forest Conservation Rules, 2022

Constitution of Different Committees:	• **Project screening committee** in each state/UT for an initial review proposal involving diversion of forest land. • **Advisory Committee** that would consists of 6 members including a chairman. It will advise with regards to grant of approval under various sections of rules. • **Regional Empowered Committee** to be set up by the Central govt in each of the regional offices. It will meet at Least twice every month to examine every referred project for approval or rejection.
Compensatory Afforestation:	Have allowed compensatory afforestation to be undertaken in States or UT **other than the one in which forest land is being diverted, de-reserved or leased.** Have introduced an **accredited compensatory afforestation mechanism**. The purpose is to encourage people to raise vegetation on its land and sell it to persons who need to meet compensatory afforestation targets under the Act. Have also permitted a State Government or UT Administration to create a **land bank** that will consist of land identified or earmarked for compensatory afforestation.
Linear Projects	All linear projects (roads, highways, etc.), projects involving forest land up to 40 hectares and those that have projected a use of forest land having a canopy density up to 0.7 will be examined in the **Integrated Regional Office.**

Key Features of Forest Conservation Rules, 2022

Consent	**Non consent of Gram Sabha** required after a project gets clearance from FAC. It will be forwarded to the State authorities who will process it for final approval.
Time Frame	Non-mining projects between 5-40 hectares: reviewed within 60 days Mining projects between 5-40 hectares: reviewed within 75 days **For projects involving a larger area:** 120 days for non-mining projects involving more than 100 hectares. 150 days for mining projects involving more than 100 hectares
Private Plantations	Allows private parties to cultivate plantations
Buildings in Forests	Provides **right to construct structures** for Bonafede purposes including forest protection measures and residential units up to an area of 250 sq metres as one-time relaxation.

National Forest Policy, 1988

The principal aim of the policy is to encourage environmental sustainability and ecological balance. It envisages that 33% of the geographical area should be under forest or tree cover.

- **Features:**
  - **Ecological Balance:** The policy stresses the importance of preserving forests to maintain ecological balance, conserve biodiversity, and regulate climate.
  - **Conservation of Natural Resources:** The policy promotes forest conservation as a valuable resource, supporting sustainable utilization of forest products and ensuring forest regeneration and productivity.
  - **Protection of Forests:** The policy stresses forest protection from encroachments, non-forest diversion, and illegal activities like logging and poaching. It calls for strict enforcement to fight deforestation and forest degradation.
  - **Involvement of Local Communities:** The policy acknowledges the importance of local communities, especially tribal populations, in forest conservation and sustainable management. It promotes their participation in decision-making and equitable sharing of benefits from forest resources.
  - **Research and Development:** The policy emphasizes research and development in forestry to improve knowledge, technology, and efficiency in forest management. It promotes research institutions, training programs, and information sharing in forestry.
  - **Joint Forest Management (JFM):** The policy backs Joint Forest Management, involving local communities in forest protection, regeneration, and management.

Joint Forest Management (JFM) in India

Joint Forest Management (JFM) is a collaborative approach that involves the participation of local communities and forest departments in the management and protection of forests. The JFM model has been implemented in many countries around the world, including India, Nepal, Bangladesh, and Indonesia.

Evolution of JFM in India

- The concept of community-based forest management was introduced in the 1970s and 1980s.
- In accordance to the National Forest Policy of 1988, Joint Forest Communities were established in various Indian states in 1990.
- Participatory Forest Management or Joint Forest Management (JFM) was adopted post Earth Summit in 1992.

Salient features of the JFM

- **Collaboration:** JFM promotes collaboration between local communities and forest departments, recognizing the importance of involving communities in decision-making processes related to forest management.
- **Community Participation:** JFM emphasizes the active participation of local communities in the management and protection of forests.

- **Sharing of Responsibilities**: JFM encourages the sharing of responsibilities between local communities and forest departments. Communities are involved in activities such as forest protection, patrolling, reforestation, and sustainable harvesting of forest products.
- **Benefit Sharing**: JFM recognizes the rights of local communities over forest resources and promotes equitable sharing of benefits derived from forests. This includes providing communities with access to forest products, income generation opportunities, and other benefits.
- **Capacity Building**: JFM focuses on building the capacity of local communities to actively participate in forest management. This includes providing training on sustainable forest practices, conservation techniques, and community empowerment.
- **Sustainable Forest Management**: JFM aims to promote sustainable forest management practices. This involves the implementation of measures to prevent illegal logging, encroachment, and unsustainable resource extraction, while also ensuring the regeneration and conservation of forests.
- **Conflict Resolution**: JFM provides a platform for resolving conflicts and addressing grievances related to forest management. It encourages dialogue and negotiation between communities and forest departments to resolve conflicts in a mutually beneficial manner.
- **Monitoring and Evaluation**: JFM emphasizes the importance of monitoring and evaluating the outcomes of collaborative forest management efforts. Regular assessments help identify challenges, measure progress, and make necessary adjustments to improve the effectiveness of JFM initiatives.

Example of Successful implementation of Joint Forest Management

In the Alwar district of Rajasthan, the coordinated action of a series of villages in protecting the forests and building a series of small bunds across the water streams has brought the river Arvari back to life.

Intensification of Forest Management Scheme

It was launched in 2009 as the "Integrated Forest Protection Scheme" and was later revised and renamed "Intensification of Forest Management Scheme" (IFMS). Main components of the scheme are:

- Forest Fire Control and Management
- Protection and conservation of Sacred Groves
- Conservation and Restoration of Unique Vegetation and Ecosystems
- Control and Eradication of Forest Invasive Species
- Preparedness for Meeting Challenges of bamboo Flowering and Improving Management of Bamboo Forests

National Afforestation Programme (NAP)

It aims at ecological restoration of degraded forests and to develop the forest resources with peoples' participation, with focus on improvement in livelihoods of the forest-fringe communities. NAP is implemented by a three-tier institutional setup through the State Forest Development Agency (SFDA) at the state level, Forest Development Agency (FDA) at the forest division level and JFMCs at village level.

Green India Mission

It was launched in 2015 as part of the National Action Plan on Climate Change (NAPCC). Major objectives include:

- To increase the forest cover in the country from the current 24% to 33% by the year 2030
- To focus on conservation, regeneration, and afforestation of degraded forests and forest lands
- To improve the ecological and socio-economic conditions of the forest-fringe communities

Note: In order to achieve the targeted objectives of national afforestation programmes, the Ministry has approved merger (w.e.f 2020) of NAP into GIM.

Mapping of Climate Change Hotspots in Indian Forests

Forest Survey of India, in collaboration with Birla Institute of Technology & Science (BITS) Pilani & Goa, Campus has been conducting Mapping of Climate hotspots over the forest cover in India using computer model-based protection of temperature and rainfall data for the three future time periods (year 2030, 2050 and 2085). The period 2030 represents a near-term timeline that coincides with the global short-term climate action horizon. Period 2050 represents the mid-term timeline and coincides with global long-term climate action goals. The period 2085 represents the long-term time horizon.

Forest Survey of India (FSI)

Background: FSI started as an organization called Pre-Investment Survey of Forest Resources (PISFR) in 1965 as Food and Agriculture Organisation of the United

Nations (FAO)/United Nations Development Programme (UNDP)/ Government of India Project. It was re-organized as Forest Survey of India in 1981.

Function: To conduct survey and assessment of forest resources in the country & to conduct training of forestry personnel in application of technologies related to resources survey, remote sensing, GIS, etc.

India State of Forest Report

The State of Forest Report is an assessment of India's forest and tree cover published every two years by the Forest Survey of India. The first survey was released in 1987, and the latest edition, ISFR 2021, marks the seventeenth iteration.

Key Terms used in the Report

Forest cover: The forest canopy area encompasses land regardless of its legal status, including tree patches that have a canopy density exceeding 10% and a size of 1 hectare or more.

- **Very Dense Forest:** Lands with a tree canopy density of 70% and above encompass all areas with significant forest cover. Within this category, the relative composition of forest cover amounts to 3.04%.
- **Moderately Dense Forest:** Areas with a tree canopy density ranging from 40% and above but less than 70% constitute this land category. Forest cover within this classification accounts for 9.33%.
- **Open Forest:** This land category encompasses areas with a tree canopy density of 10% and above but less than 40%. Within this classification, the forest cover represents 9.34%.
- **Scrub Forest:** This category pertains to lands with a canopy density below 10%. The geographical area covered by this classification amounts to 1.42%.
- **Non-Forest:** This category encompasses lands that do not fall into any of the aforementioned classes, including bodies of water. The geographical area classified as non-forest in this category comprises 76.87%.

Canopy density: Forest canopy cover refers to the percentage of an area on the ground that is occupied by the overhead crown of trees.

Recorded Forest Area (RFA): Forest Area, also known as recorded forest area, encompasses all geographic regions that are officially documented and recorded as forest in government records.

- Recorded forest areas include both Reserved Forests and Protected Forests.
- The recorded forest area may encompass any areas that have been officially recognized as forests under State Acts, local laws, or recorded in revenue records.

Trees Outside Forest (TOF): Trees located beyond the recorded forest regions, referred to as Trees Outside Forests (TOF), encompass all trees that grow outside these designated areas, regardless of their patch size, which may even exceed 1 hectare.

Tree cover: Tree cover refers to the various clusters of trees that exist outside Reserved Forest Areas (RFA) and are smaller than 1 hectare, encompassing scattered trees as well. It plays a crucial role within the broader category of Trees Outside Forests (TOF). Hence, tree cover is regarded as a subset of TOF, highlighting the smaller tree patches outside RFAs.

Forest & Tree Cover: The combination of 'forest cover' and 'tree cover' forms the overall 'Forest & Tree Cover,' which serves as a crucial metric for tracking progress in alignment with the National Forest Policy's objective of attaining 33% of the nation's geographical area under green cover.

Highlights from ISFR 2021

- **Largest forest cover:** Area-wise Madhya Pradesh has the largest forest cover in the country.
- **Maximum increase in forest cover:** The increase was witnessed in Andhra Pradesh (647 sq km) followed by Telangana (632 sq km) and Odisha (537 sq km).
- **Forest cover:** 17 states/UT's have above 33 percent of the geographical area under forest cover. Total Forest and Tree Cover is nearing one-fourth of the total geographical area of the country.
- **Carbon stock:** Total carbon stock in the country's forest is estimated to be 7,204 million tonnes, an increase of 79.4 million.
- **Mangrove cover:** Total mangrove cover in the country is 4,992 sq km, an increase of 17 sq Km observed.
- **Cities:** Delhi has the largest forest cover (194.24 sq km) followed by Mumbai (110.77 sq km) and Bengaluru (89.02 sq km.).
  - Hyderabad has shown a maximum decadal increase of 48.65 sq km in Forest cover followed by Delhi with an increase of 19.91 sq km.

Forest Research Institute, Dehradun

- **Background:** It has its roots in the erstwhile Imperial Forest Research Institute established in 1906 to organize and lead forestry research in the country. In 1988, FRI and its research centers were brought under the administrative umbrella of Indian Council of Forestry Research & Education (ICFRE) under the Environment Ministry.
- **Functions**: It conducts research, education, training, and extension activities in various fields of forestry and allied sciences.

National Afforestation and Eco-Development Board (NAEB)

NAEB is a national level organization established in 1992. The main aim of NAEB is to promote afforestation and eco-development activities in degraded and desert areas of the country, with the goal of combating desertification and improving the overall health of India's ecosystems.

Compensatory Afforestation Fund (CAF)

The CAF is a source of financing for compensatory afforestation activities in India, created to compensate for the loss of forests due to development activities, such as mining, hydropower projects, and infrastructure development. It is managed by **Compensatory Afforestation Fund Management and Planning Authority (CAMPA)**

Van Vigyan Kendra (VVK) or Forest Science Centers (FSC)

It was established by the Indian Council of Forestry Research and Education (ICFRE) of the Ministry of Environment and Forests & Climate Change.

- **Aim:** To help disseminate various technologies developed by farmers, forest-based industries and forest research institutes.
- **Activities:** Field research of silviculture, tree improvement, soil & water conservation techniques, and afforestation techniques for saline land, techniques for forestry extension, organic farming and composting techniques, sustainable land-use systems and introduction and evaluation of both timber and non-timber species.

Nagar Van Yojana

It was launched in 2020 by MoEFCC. It targets to set up 400 Nagar Vans and 200 Nagar Vatikas in India during the period of 2020-21 to 2024-25. The funding for the scheme comes from National Funds under Compensatory Afforestation Fund Management and Planning Authority (CAMPA).

The main objectives of the Nagar Van Yojana are as follows:

- Enhance the tree outside forests and green cover,
- enhancement of biodiversity and ecological benefits to the urban and peri-urban areas
- improving quality of life of city dwellers.

Bamboo Cultivation in India

About Bamboo

Bamboo belongs to the sub-family Bambusoidae of the family Poaceae (Gramineae). They are the fast growing perennial plants and are mostly found in tropical, sub-tropical and mild temperate regions of the world.

Distribution of Bamboo in India

- There are about 1200 species of bamboo in 90 genera across the world.
- India has about 125 indigenous and 11 exotic species of bamboo from 23 genera.
- The major bamboo genera found in India are:
- Arundinaria which occurs in the temperate region and are common at high altitudes in the western and eastern Himalayas.
- Bambusa and Dendrocalamus are species of tropical conditions.
- Gigantochloa rostrata is important species of semi evergreen forests of Andaman Islands.
- Phyllostachys is predominant species of temperate to warm temperate regions.
- Dendrocalamus strictus is predominant species of dry deciduous forests.
- Bambusa bambos thrives in the moist deciduous forests.

Status: The Government of India promulgated the Indian Forest (Amendment) Ordinance, 2017 to exempt bamboo grown in non-forest areas from definition of tree. the requirement of felling/transit permit for its transport and economic use was removed. This has helped in increasing the income of farmers and also increased green cover of the country.

Benefits of Bamboo Cultivation

- It contributes to subsistence needs of 2.5 billion people around the world, a majority of whom are tribals, forest dwellers or communities dependent on forest resources.
- Around 2 million traditional artisans are dependent on harvesting, processing, value addition and selling of bamboo products such as baskets, handicrafts, mats etc.
- It does not require a huge initial investment which helps small entrepreneurs to make a variety of products from bamboo.
- It plays an important role in biodiversity conservation, carbon sequestration and conservation of soil moisture.
- It is helpful in making normal and fine quality paper, fishing poles, flooring, furniture, handicrafts, walking sticks etc. due to its various properties like availability in different sizes, light weight yet strong, hard, flexible, straight, fast growing, abundant.

National Bamboo Mission

- It was launched as a centrally sponsored scheme in 2006-07 and was subsumed under Mission for Integrated Development of Horticulture during 2014-15. Restructured National Bamboo Mission was approved in 2018.
- It envisages promoting holistic growth of bamboo sector by adopting area-based, regionally differentiated strategy and to increase the area under bamboo cultivation and marketing.

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DESERTIFICATION

Land degradation is the reduction or loss of biological productivity, ecological integrity or economic productivity of land. It arises out of various direct or indirect human-induced processes such as anthropogenic climate change, pollution of soil etc. Desertification, on the other hand, means transformation of land into desert like conditions. The UN Convention to Combat Desertification defines it as 'land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities".

Various human activities such as unsustainable agricultural practices, overgrazing, deforestation and natural factors such as extreme weather events have accelerated land degradation and desertification. In recent years, land degradation and desertification have become a serious environmental issue resulting into food insecurity, loss of biodiversity, and increased environmental refugees.

Extent of Desertification

Global

According to the 2018 **World Atlas of Desertification,** published by Joint Research Centre of the European Commission-

- Over 75% of the Earth's land area is already degraded.
- Over 90% could become degraded by 2050.
- Globally, a total area half of the size of the European Union (4.18 million km²) is degraded annually.
- Africa and Asia are the most affected regions from desertification.

India

According to the **Desertification and Land Degradation Atlas of India, 2021,**

- During 2018-19, 97.85 million hectares (mha), i.e., 29.32% of India's total geographical area (TGA) of 328.72 mha underwent land degradation.
- During the same period, 83.69 mha underwent desertification.
- In all states and UTs except, Uttar Pradesh, Rajasthan and Telangana, land degradation and desertification had increased.

Causes of Desertification

Desertification is a complex process and results from an interaction of natural and human factors. The primary causes of desertification are as follows:

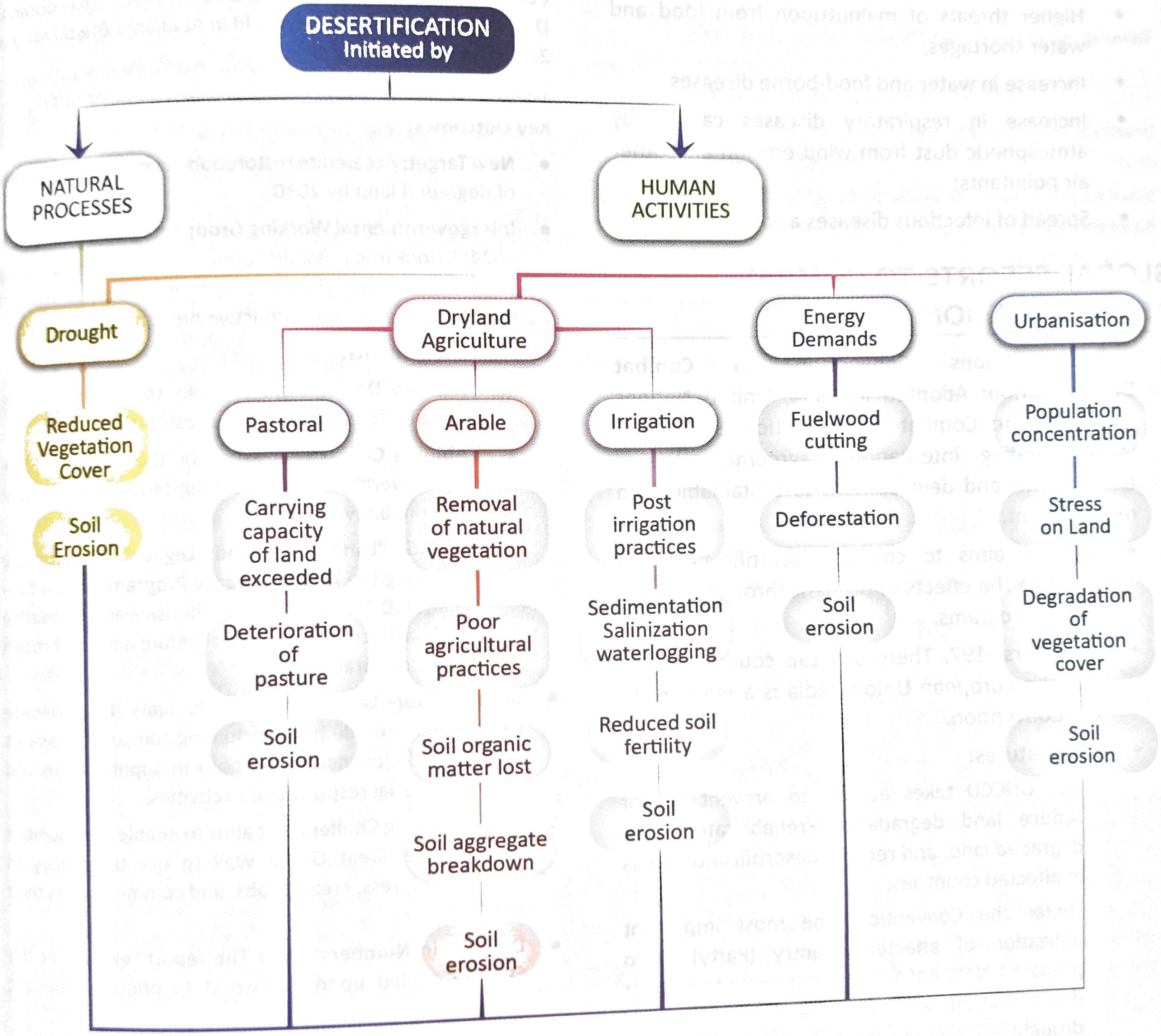
Natural Causes

- **Drought:** It is a consequence of natural reduction in the amount of rainfall received over an extended period of time. The reduction in water availability often result in reduced plant cover This exposes the soil particles to wind and water erosion after droughts and results in land degradation and desertification.
- **Water Erosion:** Extensive erosion by water leads to badland topography- the initial stage of desertification. In 2018-19, Loss of soil cover, mainly due to rainfall and surface runoff (11.01%), was one of the prime reasons for desertification
- **Wind Erosion:** Drifting sand and migrating sand dunes in severe wind erosion areas make soil more prone to desertification. In 2018-19, wind erosion was responsible for 5.46 % of the desertification in India.

Anthropogenic Causes

- **Unsustainable Agricultural Practices:** Extensive and frequent cropping of agricultural areas, excessive use of fertilizers and pesticides, and shifting cultivation without allowing an adequate period of recovery contribute to desertification.
- **Overgrazing:** Overgrazing of livestock increase soil crusting, reduce infiltration, and expose soil to increased erosion. Continued soil erosion in overgrazed areas lead to desertification.
- **Deforestation**: It disrupts the balance of nutrients in the soil and removes the roots that helps bind the soil together. This exposes the soil to erosion and accelerates desertification. In 2018-19, vegetation degradation was responsible for 9.15 per cent of desertification in India.

- **Poor Water Management:** Poor and inefficient irrigation practices, and over abstraction of ground water, results in salt water intrusion and lowering of groundwater table. These factors contribute to desertification.
- **Urbanization:** Rapid, unplanned urbanization reduces vegetation cover and green spaces, and increase the exposure of soil to erosion and accelerate land degradation and desertification. Further, cities initiate desertification processes through unsustainable consumption patterns.
- **Climate Change:** It will accelerate desertification through alteration of spatial and temporal patterns in temperature, rainfall, solar radiation and winds.



Desertification

Impact of Desertification

- **Environmental Impact:** Major environmental impacts of desertification include:
  - Increased frequency of wind and water erosion of soil,
  - Increased flooding due to degradation of surface vegetation
  - Decline in biological productivity of land- this is detrimental to wild species.
  - Soil loses capacity to absorb carbon dioxide. This may initiate regional shifts in climate.
- **Socio-Economic Impact:**
  - Desertification leads to loss in agricultural productivity and drive people to poverty and hunger.

  - Poverty induced mass migration takes place due to desertification. For example, thousands of Somalis and Ethiopians have fled to refugee camps in Kenya due to desertification induced poverty.
- **Impact on Human Health:** The impact on human health includes:
  - Higher threats of malnutrition from food and water shortages;
  - Increase in water and food-borne diseases
  - Increase in respiratory diseases caused by atmospheric dust from wind erosion and other air pollutants;
  - Spread of infectious diseases as people migrate

GLOBAL EFFORTS TO COMBAT DESERTIFICATION

- **United Nations Convention to Combat Desertification:** Adopted in 1994, United Nations Convention to Combat Desertification is the sole legally binding international agreement linking environment and development to sustainable land management.
  - **Aim:** It aims to combat desertification and mitigate the effects of drought through national action programs.
  - **Members:** 197. There are 196 country Parties and the European Union. India is a member to the Convention.
  - **Key Features:**
    - The UNCCD takes actions to prevent and/or reduce land degradation, rehabilitate partly degraded land, and reclaim desertification areas in affected countries.
    - Under the Convention, the most important obligation of affected country (Party) is to prepare a National Action Programme to combat desertification and mitigate the effects of drought.
    - **Finance:** The UNCCD does not have a centralized financial mechanism for projects. However, in 1994, the **Global Mechanism (GM)** was established to facilitate the mobilization of financial resources to implement the Convention and address desertification, land degradation and drought.
- **Bonn Challenge:** It is a global effort to bring 150 million hectares of degraded and deforested landscapes into restoration by 2020 and 350 million hectares by 2030. It was hosted and launched in 2011 by Germany and the International Union for Conservation of Nature (IUCN) in Bonn. The Bonn Challenge is based on the **Forest Landscape Restoration (FLR)** approach.

COP15 of the UNCCD

COP15 of the United Nations Convention to Combat Desertification (UNCCD) was held in Abidjan, Côte d'Ivoire in 2022

Theme: 'Land. Life. Legacy: From scarcity to prosperity'

Key Outcomes:

- **New Target:** Accelerate restoration of one billion hectares of degraded land by 2030.
- **Intergovernmental Working Group on Drought for 2022-2024:** To look into possible options, including global policy instruments and regional policy frameworks, to support a shift from reactive to proactive drought management.
- **New Declarations:**
  - **Abidjan Declaration:** It seeks to achieve gender equality for successful land restoration.
  - **Abidjan Call:** It was issued by the Heads of State and Government to boost long-term environmental sustainability.
  - **COP15 "Land, Life and Legacy" Declaration:** including the **Abidjan Legacy Programme**, is a five-year, USD 1.5 billion comprehensive and innovative approach to fight against deforestation through forest restoration.
- **Business for Land initiative**: It aims to showcase commitments made by participating companies towards land degradation neutrality, both in supply chains and corporate social responsibility activities.
- **Sahel Sourcing Challenge:** It aims to enable communities growing the Great Green Wall to use technology to monitor progress, creates jobs, and commercializes their produce.
- **Drought in Numbers 2022:** The report released at the COP 15, called upon the world to prioritize drought preparedness and resilience.

- **Sustainable Development Goal (SDG):** SDG 15.3 seeks to combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world by 2030.
- **Integrated Drylands Development Programme (IDDP):** It is an initiative launched by the United Nations Development Programme (UNDP) to promote sustainable land use practices and combat desertification in dryland areas.

Land Degradation Neutrality (LDN)

The concept was introduced by UNCCD during the Rio+20 conference in 2012. It has been adopted as part of the 2030 Agenda for Sustainable Development in 2015. LDN aims to preserve the land resource base by ensuring no net loss of healthy and productive land.

Achieving LDN involves three actions:

- Avoiding new degradation of land by maintaining existing healthy land
- Reducing existing degradation by adopting sustainable land management practices
- Increasing efforts to restore and return degraded lands to a natural or more productive state.

DO YOU KNOW?

In 1994, the United Nations General Assembly declared **17 June** as the **"World Day to Combat Desertification and Drought"**. It aims to promote public awareness and the implementation of the UNCCD in the desertification affected countries.

INDIA'S EFFORTS TO COMBAT DESERTIFICATION

- **Commitment to UNCCD and SDG:** India intends to achieve land degradation neutral status by 2030. India is also working towards restoring 26 million hectares of degraded land by 2030
- **National Action Plan to Combat Desertification (NAPCD):** It is a comprehensive plan launched by the Government of India in 2010. It aims to address the primary causes of desertification and land degradation in India. It also seeks to promote sustainable land use practices that will benefit both the environment and local communities.
- **Integrated Watershed Management Program (IWMP):** Since 2009-10, the programme is being implemented by Department of Land Resources of Ministry of Rural Development. In 2015, the programme was amalgamated as the Watershed Development Component of Pradhan Mantri Krishi Sinchayee Yojana. The **main objectives** of the programme are:
  - » Preserve and conserve the ecology,
  - » Restore and develop degraded natural resources by arresting soil loss, improving soil health, soil-moisture regime augmentation,
  - » Promote water harvesting, recharging ground water,
  - » Enhance crop production
  - » Promote livelihood and gainful employment opportunities.
- **Desert Development Programme:** The program was launched in 1977. The nodal agency is Department of Land Resources, Ministry of Rural Development.
  - ◆ **Aim:** It aims to minimize the adverse effect of drought and to rejuvenate the natural resource base of the identified desert areas.
  - ◆ **Coverage:** It is implemented in 235 blocks in 40 districts of 7 States/UT. These include Andhra Pradesh, Gujarat, Haryana, Karnataka, Rajasthan (all hot-desert areas), and Himachal Pradesh and Jammu and Kashmir (cold-desert areas).

Case Study: Desertification in Sahel Region, Africa

Location: The Sahel is a semi-arid region in Northern Africa that extends from the Atlantic Ocean in the west to the Red Sea in the east. It forms a transitional zone between the arid Sahara Desert to the north and the belt of humid savannas to the south.

Causes of Desertification: The region has undergone extreme levels of desertification due to various factors such as severe droughts, deforestation, soil erosion, overgrazing and climate change.

Great Green Wall Initiative: Started in 2007, the Great Green Wall is an Africa-led initiative to combat the effects of climate change and desertification and build resilient landscapes and livelihoods. It aims to grow an 8,000km-long line of trees and plants across the entire Sahel region.

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SOIL EROSION AND POLLUTION

SOIL EROSION

According to the Food and Agriculture Organization (FAO), soil erosion is the accelerated removal of topsoil from the land surface through water, wind, and tillage. In simple terms, the top layer of the soil is the most fertile layer that supports agricultural and other biological activities. When this top layer is removed due to various factors, the soil becomes infertile and barren, which s known as Soil erosion.

Causes of Soil Erosion

Soil erosion caused by natural events

- **Strong Winds**: Strong winds cause soil erosion by blowing away the top layer of soil, leaving the soil exposed and vulnerable to further erosion.
  - **Mechanism**: The mechanism of strong winds causing soil erosion is primarily through the process of **saltation**- the movement of sand, by short bounces along the soil surface.
  - **Factors:** Wind speed, size and distribution of soil particles, soil moisture content, soil structure, topography, climate, amount of vegetation cover and etc.
- **Rainfall:** Heavy rainfall leads to soil erosion by washing away soil particles and carrying them downstream.
  - **Mechanism:** The mechanism of heavy rains causing soil erosion is primarily through the process of water erosion.
    - When rain falls on unconsolidated soil, the water droplets dislodge soil particles and cause them to detach from the soil surface.
    - As the rainwater flows over the soil surface, it accumulates and form runoff, which carry soil particles with it.
    - This runoff increases in velocity and volume as it flows downhill, and eventually leads to the formation of gullies, rills, and other erosion features.
  - **Factors:** The factors include intensity and duration of rainfall, the slope and topography of the land, the soil type and structure, and the amount of vegetation cover.

Natural Calamities: Natural disasters such as floods, landslides, and earthquakes cause soil erosion by moving large amounts of soil and debris.

- **Floods:** Floods cause soil erosion through the process of water erosion. Floods occur when a river or other water body overflows its banks and inundates the surrounding land. This lead to the displacement of soil, rocks, and other materials, as well as the formation of new channels and erosion features.
  - **Factors:** The severity of flood depends upon the amount of precipitation, land use changes, topography, the impact of infrastructure, and urbanization. The severity of flood increases soil erosion accordingly.
  - **Cause:** During a flood, the velocity and volume of water increase significantly, which causes significant erosion of the soil and riverbed. The fast-moving water dislodges soil particles and carries them downstream, leading to the loss of fertile topsoil and other nutrients.
- **Landslides:** Landslides are both a cause and a result of soil erosion. A landslide occurs when a mass of soil, rock, or debris moves down a slope under the influence of gravity.
  - **Factors:** Landslides are triggered by factors like heavy rainfall, earthquakes, and human activities such as mining and construction.
  - **Causes:** One of the major causes of landslides is the loss of slope stability due to soil erosion. When soil is removed or displaced from a slope, the remaining soil may become unstable and more prone to failure. Water erosion mostly weakens the soil structure and makes it more susceptible to landslides.

- **Earthquake**: Earthquakes cause natural erosion through several mechanisms.
  - **Factors:** The extent and severity of erosion caused by factors like the type of soil, rock present, and steepness.
  - **Cause:** The primary cause of erosion during an earthquake is the shaking and displacement of soil and rock layers, which cause landslides, rockfalls, and debris flows. These mass movements of soil and rock result in significant erosion, as they displace and transport large quantities of material downslope.

Soil erosion caused by anthropogenic events

- **Overgrazing:** Overgrazing by livestock remove vegetation cover and leads to soil compaction, which increases the risk of erosion. Overgrazing causes the depletion of soil nutrients, making it harder for plants to grow and reducing soil fertility.
- **Mining**: Mining activities contribute to soil erosion. Mining leads to the removal of the top layer of soil, which contains organic matter and nutrients that are essential for plant growth. This results in soil degradation and reduced soil fertility.
- **Deforestation**: When forests are cleared for agriculture, grazing, or development, the protective layer of vegetation that helps to hold soil in place is removed. This leads to increased runoff, soil compaction, and decreased soil fertility.
- **Urbanization**: Urbanization lead to increased soil erosion due to the removal of vegetation cover, increased impenetrable surfaces, and altered drainage patterns. As cities grow, the amount of land available for agriculture and natural habitats decreases, leading to increased soil erosion in surrounding areas.

Soil Salinization

Soil salinization is the process by which salt accumulates in the soil to levels that are harmful to plant growth. This can occur naturally in arid regions where high evaporation rates cause salt to accumulate in the soil over time. It can also be caused by human activities such as irrigation with salty water or excessive use of fertilizers. Repeated irrigation can cause salt to build up in the soil, leading to decreased crop yields or even complete crop failure.

Example:

- In the state of Gujarat, the high use of water for irrigation has caused salt accumulation in the soil, leading to reduced crop yields and degradation of soil quality.
- In the state of Haryana, the use of poor-quality irrigation water has caused a salt buildup in soil, leading to reduced yields of crops such as wheat and rice.
- In the state of Rajasthan, the use of groundwater with high levels of salt has caused soil salinity, leading to poor crop growth and reduced yields.

Soil Alkalinization

Soil alkalinization is the process by which the pH of soil becomes too high, making it difficult for plants to grow. This can occur naturally in regions with high levels of limestone or other alkaline rocks. It can also be caused by human activities such as the excessive use of lime to correct soil acidity. In some cases, soil alkalinization can also lead to the accumulation of toxic elements such as boron or selenium, which can further harm plant growth.

Examples:

- In the state of Punjab, excessive use of lime to correct soil acidity has led to soil alkalinization and reduced crop yields.
- In the state of Andhra Pradesh, high levels of lime and other alkaline minerals in the soil have led to soil alkalinization, reducing yields of crops such as groundnut and cotton

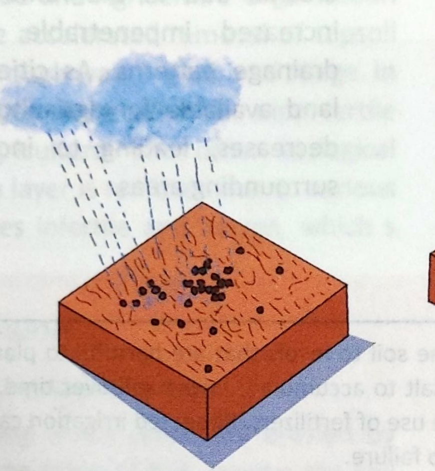
Types of soil erosion

There are several different types of soil erosion depending on the type of soil that is removed from the ground.

- **Splash Soil Erosion:** It is also known as Raindrop erosion, it occurs when a raindrop hits the soil and dislodges particles of soil, splashing them up and away. Once freed, these particles are more vulnerable to being swept away by other forces. The splash soil erosion is very difficult to detect with the naked eye and generally gets unnoticed and ignored.
- **Sheet Soil Erosion:** It is the next stage after the splash soil erosion. It occurs when heavy rainfall removes the entire top layer of the soil like a sheet over an entire landscape. This type of soil erosion also gets unnoticed and is practically invisible. Light-colored

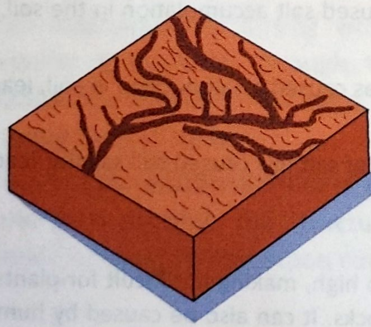
soil is often a clue that years of rain-driven runoff may have been eroding valuable topsoil. The unprotected and sloping grounds are more vulnerable to Sheet erosion.

- **Rill Erosion:** It is generally considered the third stage or type of soil erosion after splash and sheet erosion. In this type of soil erosion, several small, clear-cut ephemeral channels get created, which are known as the rills. These rills are generally less than 30 cm deep. They are easily noticed on the ground and are restricted through tillage, but if they are ignored or allowed to progress, they will lead to Gully Erosion.
- **Gully Erosion:** It is considered the most disastrous and destructive type of soil erosion as it completely destroys the soil profile of the landscape. It is the next stage of rill erosion, which occurs when the rills get wider and deeper due to the continuous flow of water. Eventually, the narrow strips of land separating the multitude of rills will be swept away, leaving one larger scar behind. Some gullies can reach up to depths of 20 feet in the presence of heavy rain. It is considered as the worst form of soil erosion because soil conservation cannot take place through normal cultivation practices.

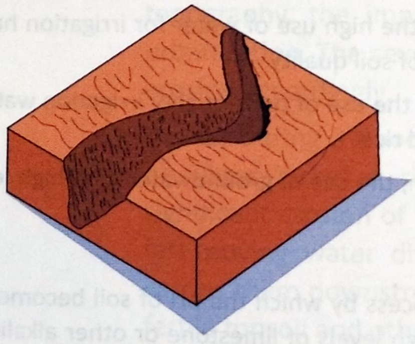


1. Splash Erosion

2. Sheet Erosion



3. Rill Erosion



4. Gully Erosion

Types of Soil Erosion

Impact of soil erosion

On Agriculture

Due to the loss of the most fertile layer, the quality and quantity of agricultural production are reduced and impact food security across the globe. Significant impacts on agriculture include:

- **Reduced soil fertility**: Soil erosion lead to the loss of valuable topsoil, which is rich in organic matter, nutrients, and microorganisms. This results in reduced soil fertility and reduced crop yields, which have significant impacts on agricultural productivity and food security.
- **Soil compaction**: Soil erosion also results in soil compaction, which reduces soil aeration and water infiltration, making it more difficult for plants to grow and develop.
- **Waterlogging**: In areas where soil erosion has caused changes in the natural drainage patterns, waterlogging occurs. This results in waterlogging of crop roots and results in crop damage.
- **Increased costs**: Soil erosion lead to increased costs for farmers, including the costs of replacing lost topsoil, increased fertilizer, and irrigation costs, and reduced crop yields.

- **Reduced soil biodiversity**: Soil erosion results in the loss of soil biodiversity, including beneficial microorganisms that support healthy soil and plant growth.

On Waterways

Transportation through rivers and other water bodies gets impacted as the waterways get clogged due to the sediments brought up with the top layer. Significant impacts on waterways include:

- **Increased sedimentation**: Soil erosion lead to the sedimentation of nearby streams, rivers, and lakes, which impacts water quality and aquatic ecosystems. The sediment reduces light penetration, covers up aquatic plants and benthic habitats, and clogs the gills of fish and other aquatic organisms.
- **Nutrient loading**: Soil erosion also carries nutrients, such as nitrogen and phosphorus, into waterways. These nutrients promote excessive growth of algae and other aquatic plants, leading to eutrophication and harmful algal blooms.
- **Reduced water quality**: Soil erosion also carries pollutants, such as fertilizers, pesticides, and other chemicals, into waterways. This impacts water quality and makes it unsafe for human consumption or recreational activities.
- **Increased flooding**: Soil erosion alters the natural drainage patterns of the landscape, leading to increased runoff and flooding. This results in property damage, loss of infrastructure, and even loss of life.
- **Habitat degradation**: Soil erosion also leads to the loss of habitat for aquatic species, which results in reduced biodiversity and ecosystem services.

Water availability

Due to the loss of the top layer, the water storage capacity of the soil gets reduced and directly impacts the availability of the groundwater.

- **Reduced retention ability**: The loss of topsoil reduces the soil's ability to hold and retain water, decreasing the amount of water available for plants and other organisms.
- **Siltation:** Soil erosion causes the siltation of streams, rivers, and other water bodies, reducing the amount of water available for human use, agriculture, and other purposes, as well as negatively impacting aquatic ecosystems.
- **Reduction in water depths:** The settling of eroded soil particles in streambeds reduces water depth and flow rate, further reducing the amount of available water.
- **Increased flooding:** Soil erosion increases the risk of flooding during heavy rain events, as soil that has lost its topsoil is less able to absorb and retain water.
- **Droughts:** In areas where the topsoil has been completely removed, the soil's ability to store water is greatly reduced, leading to drought conditions during periods of low rainfall.

Desertification

The prolonged condition of soil erosion leads to desertification and loss of vegetation in the area.

- **Reduced soil erosion:** When soil erosion occurs in arid and semi-arid regions, it increases the effects of desertification by reducing the soil's ability to retain water. This lead to vegetation loss.
- **Increase in wind erosion:** The loss of vegetation due to soil erosion also leads to increased wind erosion. Without plants to hold the soil, the wind picks up and carries away loose soil particles, leading to further degradation of the soil and the surrounding ecosystem.
- **Loss of biodiversity:** Soil erosion also leads to the loss of biodiversity in affected areas, as many species of plants and animals depend on a healthy soil ecosystem for survival. This further accelerates the process of desertification, as the loss of biodiversity reduces the resilience of the ecosystem to environmental stresses and disturbances.

Soil conservation Methods

Soil conservation is the practice of protecting the soil profile and its erosion from different natural and anthropogenic factors. It includes reversing and restoring the already-impacted landscape. Soil Conservation methods are basically divided into five broad categories, namely

- Agronomic practices
- Structural practices
- Vegetative practices
- Engineering practices
- Cultural practices

Agronomics Practices:

Agronomic practices involve changes in how crops are grown and aim to improve soil health, reduce erosion, and increase crop yields. It involves the following methods:

- **Rotation of Crops:** This involves rotating different crops on a given plot of land to promote soil health, break pest, and disease cycles, and maintain soil fertility. Crop rotation also helps to reduce erosion by alternating crops with different root structures and nutrient requirements.

Under this, the crops are rotated scientifically, which allows the soil to restore and refresh for the next cycle. In simple terms, sowing of soil-enriching Leguminous (Nitrogen fixing) crops after the soil exhaustive non-Leguminous crops in the field.

For instance: Sowing of peas, soya beans, clover, and lupine (Soil enriching) after the Rice or Wheat (Exhaustive Crops).

- **Cover Cropping:** It involves Planting crops such as clover, rye, or alfalfa during the off-season to protect soil from erosion and improve soil health. Cover crops can also help suppress weeds, fix nitrogen in the soil, and improve soil structure.
- **Conservation Tillage:** It involves reducing the amount of tillage or ploughing done on the land to minimize soil disturbance and erosion. Examples of conservation tillage methods include no-till and reduced-till farming, which leave some crop residue on the soil surface to protect against erosion and maintain soil structure.
- **Nutrient Management:** It involves regular testing soil to determine nutrient levels and using appropriate fertilizer and nutrient management practices to prevent soil degradation. This can include using organic fertilizers, avoiding overuse of synthetic fertilizers, and carefully timing fertilizer application to minimize runoff and leaching.
- **Strip Cropping**: Under this method, the entire landscape is divided into strips parallel to each other. Then, these strips are sown with different types of crops, while sometimes some strips are left unsown. These strips are wide enough to allow independent cultivation but narrow enough to interact agronomically with each other.
    - The different types of crops ripen at different times and harvested at intervals which ensures that at no point in time in a year the entire land is left unsown and exposed to erosion. The tall-growing crops work as wind-breaks and the strips, help to increase water absorption by the soil by slowing down run-off.
- ***Mixed Cropping:*** *It is the practice of growing two or more crops simultaneously on the same piece of land with one being the main crop and the others* being subsidiary crops. Different crops have different maturity periods and different nutrient needs, which complement each other and do not exert pressure on the soil. There is no definite cropping pattern between the crops
- **Crop Diversification:** Monoculture exhausts the nutrient availability of the soil and makes it more vulnerable to soil erosion. On the other hand, crop diversification, under which different crops are sown on the piece of land in different seasons, allows the soil to replenish its nutrients and improve its fertility.

Structural Practices

It involves physical changes to the landscape and aims to slow down the movement of water across the landscape, prevent erosion, and protect soil and crops. It involves the following methods:

- **Contour Ploughing:** It involves tilling the field at right angles (90 degrees) to the natural slope after drawing up the elevation contour lines. These contour lines act as the barrier in the path of water and wind soil erosion and hence protects the removal of the top layer of the soil.
- **Terraced Farming**

Under this method, several steps known as terraces are built on the sloping side of the mountain to maximize the arable land. These steps act as the barrier and protect the runoff of the soil with the water, hence combating soil erosion.

- **Grassed waterways:** Planting grasses or other vegetation in natural drainage channels to slow down the movement of water and prevent erosion. This can help protect soil and crops from damage during heavy rainfall events.

Vegetative practices

It involves planting or managing vegetation to protect soil and promote its health. It consists of the following methods:

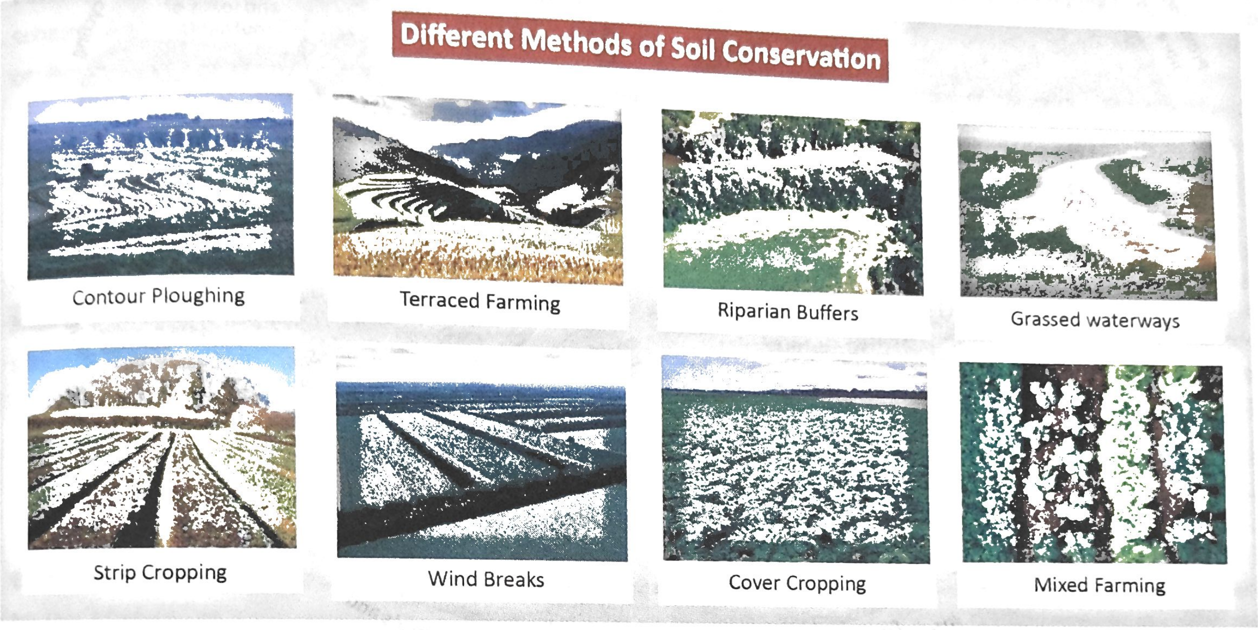
- **Development of Wind Breaks:** In the areas of strong winds and loosely held soil particles, the soil is vulnerable to the prevailing strong winds. Under this method, one or more rows of trees and shrubs of different heights are planted perpendicular to the direction of the winds.
- **Riparian Buffers:** Planting vegetation along the banks of streams and rivers to protect them from erosion and filter out pollutants. This can help improve water quality and promote biodiversity.

Engineering practices

It involves the construction of physical structures to protect soil erosion and preserve its fertility.

- **Dams and Dikes:** Dams and dikes are structures built to control water flow and prevent erosion. They can protect fields from flooding and stabilize stream banks but should be carefully planned due to potential ecological impacts.
- **Drainage systems:** Drainage systems remove excess water from fields to prevent soil erosion and improve crop yields. They can be designed using different methods and materials but should be implemented sustainably and consider potential impacts on water quality and ecosystem health.

Different Methods of Soil Conservation



Contour Ploughing
Terraced Farming
Riparian Buffers
Grassed waterways
Strip Cropping
Wind Breaks
Cover Cropping
Mixed Farming

SOIL POLLUTION

Soil Pollution is defined as contamination of soil by human and natural activities which may cause harmful effect on living organisms.

Causes of Soil Pollution

- **Industrial and Mining Activities:** Industrial effluents like harmful gases and chemicals pollute soil.
- **Modern Agricultural Practices:**
  - Use of chemicals in agriculture like pesticides, fertilizers and insecticides
  - Poor soil management system
  - Poor irrigation practices.
- **Poor Waste Disposal**: Unhealthy waste management techniques release sewage into dumping grounds and nearby water bodies.
- **Accidental Oil Spills:** Oil leaks during storage and transport of fuel deteriorates the quality of soil and make them unsuitable for cultivation
- **Radioactive Pollutants**: Radioactive wastes penetrate the soil and accumulate giving rise to soil pollution.
- **Acid Rain:** It dissolves away some of the important nutrients found in soil and change the structure of the soil.

Impact of Soil Pollution

- **Effect soil biodiversity:** Soil pollution alters soils' biodiversity, reduces soil organic matter and soils' capacity to act as a filter.
- **Water pollution**: It contaminates the water stored in the soil and groundwater.
- **Effects plant growth:** When the chemistry of the soil changes dramatically in a short period of time due to pollution, most plants are unable to adapt.
- **Effects soil microorganisms**: The fungi and bacteria in the soil that hold it together start to deteriorate as a result of pollution, causing soil erosion.
- **Decreases fertility**: Soil pollution decreases soil fertility. As a result, there is reduction of crop yields and quality.
- **Impacts Human Health:** Pollutants in soil can cause a variety of diseases, from short-term acute effects, such as intoxications or diarrhea to long-term chronic effects, like cancer.

INDIAN INITIATIVES FOR SOIL CONSERVATION

- **National Soil Health Card Scheme**
- The scheme was launched in February 2015 by the Ministry of Agriculture and Farmers Welfare. It aims to promote sustainable agriculture practices by helping farmers make informed decisions about fertilizer use and reducing the risk of overuse of fertilizers, which can lead to soil degradation.
- **Key Features**
  - Under this scheme, soil samples are collected from agricultural fields and tested for various parameters such as pH, nutrient content, and organic matter.
  - Based on the test results, farmers are provided with soil health cards that contain information on the nutrient status of their soil and recommendations for appropriate fertilizer use.
- **Soil Conservation in North Eastern Region (SCNER):** The program was launched in 1983 by the Ministry of Agriculture and Farmers Welfare. It aims to promote soil conservation and sustainable agriculture practices in the north-east region through interventions such as afforestation, terrace farming, and conservation of soil and water resources.
- **Rastriya Krishi Vikas Yojana (RKVY):** The scheme was launched in August 2007 by the Ministry of Agriculture and Farmers Welfare. This scheme is a centrally sponsored program that aims to promote sustainable agriculture practices, improve soil health, and increase agricultural productivity. The scheme provides financial support to states for a range of interventions such as soil testing, crop diversification, and organic farming. The scheme also encourages the adoption of innovative technologies and practices that promote sustainable agriculture and reduce the risk of soil degradation.

- **National Mission for Sustainable Agriculture (NMSA):** The mission was launched in February 2010 by the Ministry of Agriculture and Farmers Welfare. It aims at promoting sustainable agriculture practices and increasing soil health. The mission focuses on interventions such as organic farming, soil conservation, and integrated nutrient management.
- **Paramparagat Krishi Vikas Yojana (PKVY):** The scheme was launched in April 2015 by the Ministry of Agriculture and Farmers Welfare. This scheme promotes organic farming and sustainable agriculture practices, including soil conservation and nutrient management. The scheme provides financial support to farmers for adopting organic farming practices and encourages the use of indigenous and traditional knowledge systems for sustainable agriculture. The scheme also provides support for the marketing of organic produce, with the aim of promoting sustainable agriculture and reducing the risk of soil degradation.
- **Watershed Development Project in Shifting Cultivation Areas:** The project was launched in 1995 by the Ministry of Agriculture and Farmers Welfare. It aims to promote sustainable land use practices, such as terracing, contour farming, and agroforestry, to conserve soil and water resources.
- **NABARD Loan- Soil & Water Conservation Scheme under RIDF:** The scheme was launched in 1995 by the National Bank for Agriculture and Rural Development (NABARD). It is implemented by NABARD under the Rural Infrastructure Development Fund (RIDF). It provides financial assistance to farmers and rural communities for implementing soil and water conservation measures, such as the construction of check dams, contour bunding, and gully plugging, to conserve soil and water resources.
- **Rashtriya Krishi Vigyan Yojana (RKVY):** The scheme was launched in August 2007 by the Ministry of Agriculture and Farmers Welfare. It aims to promote agricultural development through scientific research and technology dissemination.

Best Practice: Sukhomajri Experiment

What had happened?

The village of Sukhomajri, located in the state of Haryana, faced severe deforestation and soil erosion in the 1970s due to overgrazing and tree-felling for firewood and timber.

Response:

A group of researchers from Panjab University in Chandigarh collaborated with the community in 1979 to create a plan for watershed management and afforestation. The project involved constructing check dams, contour trenches, and percolation tanks to conserve water and prevent soil erosion. Villagers were also assisted in planting trees and shrubs, such as acacia, eucalyptus, and bamboo, on degraded lands.

Success:

The project achieved considerable success in restoring the area's soil and water resources, resulting in higher agricultural productivity and improved biodiversity. The check dams and percolation tanks helped to recharge groundwater and prevent flooding during the monsoon season, while the afforestation program led to the regeneration of degraded lands and the restoration of the local ecology.

Steel Slag

It is a by-product of the steelmaking process, which is produced during the separation of molten steel from impurities in the blast furnace or basic oxygen furnace. It is formed when the mineral components of the steel-making process (such as iron ore, coke, and limestone) fuse together and form a slag on top of the molten steel. It is one of the main sources of environmental **pollution** caused by heavy metals

Composition: It is a hard, dense, and porous material that is composed of a mixture of various minerals and metal oxides, including iron, calcium, silicon, magnesium, and aluminium.

Application: Steel slag is a very valuable product that finds numerous applications in domestic and industrial processes, including

- **Construction Material:** in roads, buildings, etc.
- **Soil Enhancement:** it improves the fertility of the soil.
- **Water Treatment:** Water quality can be improved with steel slag
- **Mineral Wool Production:** Steel slag is used as a raw material
- **Landscaping:** Its dark colour and angular shape provide a unique and attractive look and often used in landscaping.